

# PUBLIC WORKS

CITY

COUNTY

STATE

AN ENGINEERING AND CONSTRUCTION MONTHLY

Vol. 60

July, 1929

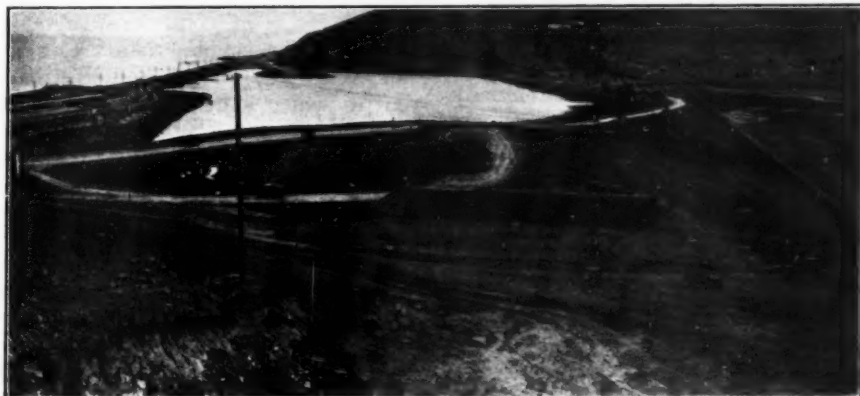
No. 7

## Bay Shore Highway, San Francisco

Built along San Francisco Bay by city and state. Location across ridges and lagoons. Land slide proves troublesome

The rugged topography of the north end of the San Francisco peninsula presents an obstacle to an easy solution of the problem of giving direct traffic connection between San Francisco and its hinterland to the south. A series of steep, high ridges extend into the waters of San Francisco bay, and the arms of the bay at one time extended inland between the ridges but are now partially filled with decayed vegetation and materials eroded from the surrounding mountains, which form soft, boggy lagoons, inundated

with underground conduits, and all necessary traffic safety devices. Pedestrian subways are being constructed at different locations to take care of school children and other pedestrians. At one point a culvert 484 feet long is being constructed to carry the flow of Islais creek, consisting of two compartments, each 8 feet 6 inches by 11 feet, resting on piles from 60 feet to 85 feet long, set four to a bent, the bents being spaced 2 feet 3 inches centers. This heavy foundation is used to give the culvert suf-



RELOCATION OF BAY SHORE HIGHWAY

Railroad embankment shows at left, pipe line on trestle at extreme right. Old highway swings around lagoon. New location will pass from cut (in which camera was standing) directly across the lagoon by fill.

by the water of the bay at times of extremely high tide.

A road is now being constructed along this route by the California State Highway Commission, as a part of the Bay Shore Highway. About three miles of the highway lie within the limits of the city of San Francisco and this is being constructed by the city under Assistant City Engineer Clyde E. Healy. The road when completed will form an important connection with the new San Francisco Bay bridge between San Mateo and the East Bay. This section within the city will be 100 feet wide with 12½ foot sidewalks and will use an 8-inch concrete base and a 3-inch wearing surface, designed to take care of future heavy truck traffic to be carried in inter-county business. It is expected that the section within San Francisco Co. will be completed and open for traffic by January 1, 1930, at a cost of approximately \$2,030,000, including the necessary right of way. In connection with it will be constructed an ornamental lighting system

ficient bearing power to support an industrial spur track which is planned for the future.

The location and construction of the Bay Shore line outside of San Francisco is complicated by the tracks of the Southern Pacific Company, and the water conduit of the Spring Valley Water Co. which carries about 50% of San Francisco's water supply. The former is a double-track line along the bay shore which tunnels through the ridges and crosses the lagoons with rock fills. The pipe line is a 44-inch steel pipe which follows near the shore of the bay, laid in a trench over the ridges which it crosses, and on pile trestles across the bogs. The location of the Bay Shore route runs generally parallel with the railroad and just inland from it, going over the ridges where the railroad tunnels through them. The grades were kept at a reasonable maximum by means of deep cuts in the ridges and fills across the lagoons. When the road has been completed on the new alignment, the existing shore highway will be abandoned.



BUILDING RETAINING WALL TO HOLD SLIDE

It was found that, in order to obtain a satisfactory alignment for the highway, it would be necessary to move the water main at four different places. A fifth place was particularly troublesome. Here the location of the pipe line was across the top of an old landslide on a hill of one of the ridges. The highway was laid along the foot of this slide and the department constructed a heavy retaining wall where the excavation for the roadway cut away the toe of the landslide, hoping that this would prevent the landslide from moving. However, with the first rains of last winter the landslide started to move. As a temporary expedient to support the water pipe where it crosses the slide, the Spring Valley Water Company constructed a suspension bridge of 170 feet span several hundred feet up hill from the retaining wall for carrying the pipe.

Just north of this point the pipe line is carried through a tunnel for 450 feet, which was necessary in order to keep the line below the hydraulic gradient, and this and the relocation of four stretches of the line with an aggregate length of 4,000 feet were done by the water company, which was reimbursed for the cost by the state.

The 4,000 feet of new 44-inch lines was fabricated by the Western Pipe and Steel Co., which sublet the digging and the backfilling to the Youdall Construction Co. The pipe is of riveted steel of quarter-inch plates 8 feet long, dipped in hot asphaltum and wrapped with soil-proof pipe covering. The pipes were delivered by trucks as near to the point of installation as possible. From these points as much pipe as possible was handled by an inclined railway which was built in connection with the construction of the tunnel.

#### Striping California Highways

A report has been made from the various road districts of California as to the mileage of pavements which will require striping. It is planned to have all sections of pavement of 20-foot width or more divided into 10-foot lanes. In foggy sections, or where there is danger to traffic, a stripe will be placed along the edge of the pavement. Very favorable comment has been received on those sections of highway where the edges of the pavement have already been so marked. The stripe will be in place before the next winter season to secure the most benefit from the expenditure.

## Working Days and Climatic Conditions.

A brief study of the effects of climate on the number of working days for highway construction in the several states

By C. N. Conner\*

Highway contractors are frequently asked to bid on the number of working days in which they will complete a contract. Failure to complete the work in contract time sometimes involves a financial penalty.

Generally this is the amount of money the state has expended for retaining inspectors and engineers on the project after the expiration of the number of working days named in the contract by the contractor, or it may be a fixed sum per day.

Some states interpret a working day as one on which the contractor can perform one of the major operations of his contract. For example: A contractor has completed the rough grading on a paving job and also a portion of the fine grading but can not lay the pavement because a heavy shower has saturated the subgrade; he can, however, haul pipe, pour headwalls for pipe culverts and work on his plant. Under these conditions the major operation of paving can not be done because of conditions beyond his control and the day is not counted as a "working day."

Resident engineers and inspectors usually keep diaries which state definitely the weather conditions of each day and whether or not that day was classed as a "working day." Such records are invaluable in cases of contracts which overrun the bid time and when the contractor complains because several hundred dollars have been deducted from his final estimate.

The definition of a working day is probably not exactly the same in all state highway departments, nor is the interpretation identical for the same definition as between states.

However, a study of the general conditions in each state of the number of working days and weather conditions is instructive. From it many interesting comparisons may be made.

The tabulation is made from data collected by the American Road Builders' Association.

For grading operations, working days range from 140 to 300; for paving, from 100 to 300.

Precipitation ranges from a minimum of 7.21 inches to 55.82 inches.

The maximum average high temperature is 113 degrees in Arizona and New Mexico, and minimum average low temperature is 52 degrees below zero in northeastern Montana.

In Florida the average last date of frost in the spring is March 10 and first frost in the fall is December 1. But in western Wyoming the last frost in spring averages July 15 and the first frost in the fall averages August 10.

The combination of cold weather and relatively high precipitation make for a short working season in New Hampshire, which reports only 100 working days for paving operations, 42 inches of precipitation.

\*Engineer Executive, American Road Builders' Association. Washington, D. C.

Tabulation of Working Days and Climatic Conditions in the Several States for Highway Construction

State	Portion	*Working Days		Mean Annual Temperature			Mean Frost Date	
		Grading	Paving	Precipitation Inches	Mean High	Mean Low	Spring	Fall
Ala.	N. & W.			49.00	105	-9	Apr. 25	Oct. 15
	E. C. & S.	240	240-300	55.32	105	0	Apr. 20	Oct. 15
Ariz.	Southern			10.95	113	+9	Apr. 15	Oct. 25
	Northern	200-300	200-300	16.12	107	-10	June 1	Sept. 20
Ark.	Southern			46.22	108	-9	Mar. 20	Nov. 10
	Northern	300	300	47.25	109	-17	Apr. 15	Oct. 15
Cal.	Southern			14.10	110	+15	Apr. 10	Nov. 1
	Central			18.85	111	+17	Apr. 20	Oct. 15
	N. Eastern			34.81	108	+4	June 1	Oct. 5
	N. Western	155-300	120-300	40.22	107	+14	May 25	Oct. 15
Colo.	S. Eastern			17.30	99	-30	June 15	Sept. 15
	N. Eastern			16.88	99	-32	June 25	Sept. 15
	Western	No Data	No Data	17.03	94	-33	July 1	Sept. 5
Conn.		180-210	125-155	42.01	99	-24	June 5	Sept. 10
Chesapeake Bay Region				42.82	104	-11	May 5	Oct. 25
Delaware	(See Chesapeake Bay Region)			(Grading 220 Days)			(Paving 160 Days)	
Fla.	Northern			53.60	103	+10	Apr. 15	Nov. 1
	Southern	240	240-up	41.43	99	+22	Mar. 10	Dec. 1
Ga.	Western			52.48	104	-4	Apr. 25	Oct. 20
	Cent. & East.	300	300	49.44	107	-2	Apr. 20	Oct. 15
Ida.	Northern			23.22	103	-24	June 25	Sept. 1
	Southern	120-200	80-120	14.56	105	-29	July 1	Sept. 1
Ill.	Northern			33.12	107	-27	June 1	Sept. 15
	Central			36.04	106	-25	May 15	Sept. 20
	Southern	180-240	120-135	41.41	109	-20	May 10	Sept. 25
Ind.	Northern			36.07	105	-23	May 25	Sept. 15
	Southern	160-175	120-140	42.52	107	-22	May 15	Sept. 20
Iowa.	Western			32.39	108	-36	May 20	Sept. 15
	Central			32.39	108	-33	May 20	Sept. 15
	Eastern	175	125	32.39	107	-31	May 25	Oct. 5
Kan.	All	200	140	28.50	111	-27	Apr. 25	Oct. 20
Ken.	Eastern			46.87	104	-20	May 10	Sept. 25
	Western	175	100	45.50	106	-21	May 10	Sept. 25
La.	Southern			56.37	106	+7	Mar. 10	Nov. 15
	Northern	225	225	49.32	107	-2	Apr. 20	Oct. 20
Maine	All	140	110	40.66	98	-29	June 15	Sept. 10
Md.	W. & Cent.	(See Potomac River Basin)						
	Eastern	180-240	140	(See Chesa. Bay Region)				
Mass.		225	150	42.01	99	-24	June 5	Sept. 10
Mich.	Upper Penin.			30.00	99	-37	June 15	Sept. 1
	Western Lower			31.00	102	-29	June 5	Sept. 10
	E. Lower	180	130	32.00	103	-29	June 15	Sept. 10
Minn.	S. Western			25.31	104	-38	May 15	Sept. 25
	S. Eastern			28.65	105	-40	May 15	Oct. 1
	Northern	150	100	24.98	102	-48	June 15	Sept. 1
Miss.	Northern			49.30	104	-6	Apr. 25	Oct. 10
	Southern	240	160	55.82	104	+2	Apr. 20	Oct. 20
Mo.	S. Western			40.00	109	-27	May 15	Sept. 20
	S. Eastern			44.98	109	-24	May 15	Sept. 25
	Northern	No Data	No Data	36.67	109	-26	May 15	Sept. 25
Mont.	S. Eastern			14.35	106	-45	June 10	Sept. 1
	S. Western			15.05	101	-43	June 20	Aug. 20
	Western			17.82	102	-33	June 20	Aug. 25
	N. Central			16.00	102	-46	June 20	Aug. 25
	N. Eastern	No data	100-120	14.27	108	-52	June 15	Aug. 25
Neb.	N. Western			19.75	106	-35	June 5	Sept. 10
	N. Eastern			27.75	109	-36	May 25	Sept. 15
	Southern	250	225	25.00	111	-33	May 25	Sept. 15
Nev.	All	240-300	150-175	7.21	106	-21	June 25	Sept. 1
N. H.		140	100	42.01	99	-24	June 5	Sept. 10
N. J.	S. I. & Coast			47.68	103	-10	May 20	Sept. 25
	Northern	190	140	47.44	104	-18	May 20	Sept. 20
N. M.	W. & S.			13.43	113	-18	May 7	Oct. 20
	N. Western			14.09	100	-22	June 15	Sept. 25
	N. Eastern	No Data	No Data	17.87	102	-20	May 25	Oct. 1
N. Y.	Western			35.20	99	-23	June 10	Sept. 10
	Central			39.09	98	-30	June 10	Sept. 10
	S. Central			38.76	99	-30	June 15	Sept. 10
	Eastern	160	150	41.68	100	-24	May 25	Sept. 15
N. C.	E. & W.			51.66	98	-16	May 20	Sept. 25
	W. Central			51.46	102	-7	May 5	Oct. 5
	C. & S. E.			48.06	104	-4	May 5	Oct. 10
	N. Eastern	200	200	48.23	102	-2	Apr. 25	Oct. 15
N. D.	Western			15.69	105	-47	June 15	Aug. 25
	Eastern	150	180	19.26	105	-46	June 15	Aug. 20
Ohio	Northern			36.74	104	-23	June 1	Sept. 15
	S. Western			39.36	105	-24	May 20	Sept. 25
	S. Central			38.68	105	-26	May 25	Sept. 20
	S. Eastern	No Data	No Data	39.38	104	-26	May 25	Sept. 20
Okla.	Eastern			38.75	110	-14	Apr. 25	Oct. 10
	Western	225-240	225-240	30.00	112	-14	May 1	Oct. 1
Ore.	Western			51.44	101	-5	June 1	Sept. 25
	Eastern	No Data	No Data	14.00	104	-24	June 20	Sept. 10
Pa.	Western			41.41	103	-14	June 5	Sept. 15
	Central			40.08	103	-24	June 5	Sept. 15
	Eastern	190	120-140	46.09	103	-18	May 20	Sept. 20
Potomac River Basin				39.37	104	-19	May 15	Oct. 5
R. I.		190-200	140-150	42.01	99	-24	June 5	Sept. 10
S. C.	Western			48.75	105	-1	Apr. 20	Oct. 15
	Eastern	210-240	180-240	47.16	105	+2	Apr. 15	Oct. 20
S. D.	Western			18.50	108	-40	June 1	Sept. 5
	Eastern	130-165	110-140	22.30	107	-42	June 25	Sept. 1
Tenn.	Middle West			50.83	104	-18	May 15	Oct. 1
	Eastern	190	175	51.66	98	-16	May 20	Sept. 25
Texas	N. Western			24.50	109	-10	May 10	Oct. 15
	Central			26.50	110	-4	Apr. 25	Oct. 20
	Eastern	240-300	180-240	40.00	111	-5	Apr. 25	Oct. 20
	Southern			31.88	107	+8	Apr. 5	Oct. 25
	W. & S.			13.43	113	-18	May 7	Oct. 20
Utah	Eastern			11.13	104	-25	June 20	Sept. 10
	Western	170-180	170-180	13.93	103	-23	June 25	Sept. 10

State	Portion	*Working Days		Mean Annual Precipitation Inches	Temperature		Mean Frost Date	
		Grading	Paving		Mean	Mean	Spring	Fall
					High	Low		
Va.	South & S. W.			43.60	100	-19	May 20	Sept. 25
	S. & E.			42.87	102	-4	Apr. 25	Oct. 10
	Central	180-210	150-180	41.60	104	-13	May 15	Oct. 5
Vt.		155	115	42.01	99	-24	June 5	Sept. 10
Wash.	Western			49.14	97	0	May 25	Sept. 25
	Eastern	180-300	150-240	15.48	107	-24	June 25	Sept. 15
W. Va.	Northern			45.84	103	-26	May 30	Sept. 25
	S. & S. W.	No Data	120-180	43.60	100	-19	May 20	Sept. 25
Wis.	N. Western			30.00	101	-43	June 10	Sept. 5
	Central			32.00	102	-41	June 10	Sept. 5
	Eastern	140-150	110	31.40	106	-32	June 1	Sept. 20
Wy.	Western			16.04	94	-46	July 15	Aug. 10
	S. Eastern			14.28	98	-38	June 20	Aug. 25
	N. Eastern	200	140-160	13.03	101	-38	June 20	Aug. 20

\*Average for entire state; number of working days per year exclusive of Sundays, holidays and bad weather.

and only three months in the year when frost may not be expected. On the other hand, Alabama reports a relatively long working season of from 240 to 300 days, in spite of precipitation of 49 and 55 inches.

Improved construction methods and equipment have done much to overcome delays caused by unfavorable weather conditions and short working seasons. Up to 1923 no paving contractor in North Carolina had laid in one day 1,000 feet of concrete pavement 18 feet wide; but since then that amount has been exceeded in the state many times. The weather has not changed but methods and equipment have been improved.

### Timber Highway Bridge in Idaho

The only direct communication between the southern part of Idaho and the northern or panhandle section is by means of a north and south highway which extends throughout the entire state. It parallels the main mountain ranges and larger streams and necessarily crosses many small streams tributary thereto, necessitating many bridges. One of these bridges which contains some unusual features was constructed by the State Highway Department in the late summer of 1928 across St. Maries river about 18 miles south of the town of St. Maries. It seemed desirable to have the bridge completed and in operation before winter set in, and the bridge was completed in 65 actual working days, pile driving having been begun 17 days after the awarding of the contract.

The bridge spans not only the main channel of the St. Maries river but also the tracks of the Chicago, Milwaukee, St. Paul and Pacific Railroad. A 75-foot Howe wooden truss, deck type, spans the river, and a 35-foot beam span crosses the railroad tracks. The bridge joins the high banks of the river on a 5% grade and is built on an 8 degree curve, super-elevated. Super-elevation is obtained by canting the 12x12x26-foot caps.

The bridge foundation consists of 5-pile bents, in which the two outer piles are driven on a 1 in 12 batter. Ten rows of stringers spaced 2 feet 9 inches on centers form the main support of the floor system, except in the case of the Howe truss. The floor is of the laminated type, of 2-inch by 6-inch planks covered with a 3/4-inch mastic wearing surface.

The Howe timber truss was entirely pre-framed, bored for bolts and assembled at the creosoting plant before creosote treatment. It was then knocked down, treated, and shipped as separate items to the bridge site, where it was reassembled and erected without difficulty. This span consists of two timber trusses

15 feet high with five 15-foot panels. The upper cord and end posts are 12 by 12 timbers; while the end, intermediate, and center diagonals are from 12 by 14-inch to 10 by 8-inch timbers.

There was difficulty in driving the foundation piles because of the shale formation at the site. Holes were drilled by hand from 3 feet to 6 feet deep and a small charge of explosive was discharged in each hole, giving holes into which the piles were placed and driven to a depth of 6 to 8 feet.

The structure was designed to carry a live load of two 15-ton trucks with no impact allowance. It was constructed throughout of Douglas fir. All of the piling and lumber except the hand rail system was treated under pressure by a standard empty cell process and a final retention of 8 pounds of grade 1 coal-tar creosote per cubic foot was obtained.

### Pennsylvania Maintains County Bridges

There are 2,127 county bridges on the highway system of Pennsylvania, of which 245 are constructed of timber, 896 of steel, and 986 of stone and concrete. The state is taking over the construction, reconstruction and maintenance of all these bridges. It plans to replace the timber bridges within the next five years, and to replace all one-way bridges no matter how constructed as soon as detailed surveys have been made and the plans drawn. All bridges, however, will have been taken over by July 1, 1930. It is expected that \$6,500,000 will be spent for bridge construction and maintenance during the next two years.

The program of the state highway department also provides that two million dollars be spent during the next two years on city streets connecting state highway routes. This includes all the cities in the state except Philadelphia, which is taken care of by special appropriation. This will materially assist smaller cities which have at times found it difficult to provide funds for keeping the state highway routes in good repair.

### Highway Expenditures by States

The Department of Commerce issued a few weeks ago the "Financial Statistics of States" for 1927, which shows payments during that year by the states of \$2,864,327,312. Of the payments for operation and maintenance of the general departments, 15.2% or \$170,792,799 was for highways, which was exceeded by only two items—charities, hospitals and corrections, 17.3%, and schools, 39.7%. Of the payments for outlays—"the acquisition and construction of more or less permanent properties and public improve-

ments"—totaling \$518,907,048, \$404,163,394 was for highways and \$35,417,167 for education and libraries.

This \$575,000,000 includes only state money, and none of that raised by counties or other civil divisions or contributed by the federal government.

Of the expenditures for outlays by individual states, Pennsylvania leads with \$26,117,375; New York is second with \$21,132,048; North Carolina is third with \$20,327,607, and Florida fourth with \$19,555,951. The smallest was by Montana—\$1,253,633.

In expenditures for operation and maintenance of highways, New York leads with \$16,372,198; Ohio is second with \$13,176,744; Pennsylvania is third

with 11,850,441; and Massachusetts is fourth with \$7,430,036.

Ohio's expenditures for maintenance were slightly more than double her payments for outlays; those of Massachusetts about 50% greater; New York's about 80% as great, and Pennsylvania's about 45% as great. Totaling all the states, the expenditures for operation and maintenance were about 42% of those for outlay. As considerable outlay was for roads that are maintained by counties or towns, it is probable that the total expenditures for operation and maintenance by all public agencies were more than 50% of those for construction.

## San Bernardino Sewage Treatment Plant

Three-pipe inverted siphon, Imhoff tanks, trickling filters, secondary sedimentation tank and sludge beds. Sludge removed by trolleys traveling on overhead monorail tracks. Gas used to operate plant. Prechlorination for odor control

By James N. Hatch

The recently completed plant for treating the sewage of San Bernardino, Calif., is located on what is known as the West Ranch, a 72-acre tract one mile south of the present city limits on the banks of Warm creek. This tract of land was low and marshy, but has been drained and filled-in, and is being landscaped and soon "shall rejoice and blossom as the rose." The plant sits back about 700 feet from the San Bernardino-Redlands state highway and is approached through an artistic gateway among great spreading cottonwood trees.

Previous to the building of this plant the disposition of the city sewage had been taken care of through a contract made in 1909 with the Delta Farms Company, who have a 600-acre tract of land on the south side of Santa Ana river about three miles from the city. This contract was made when the city's population was only about 10,000 and was to run for twenty-five years. But owing to the rapid growth of the city this method had become outgrown by 1924 and it became evident that something radical must be done to meet the enlarged requirements. This problem was investigated very carefully by the city authorities during a period of over three years, and after consulting several engineers the city finally retained the

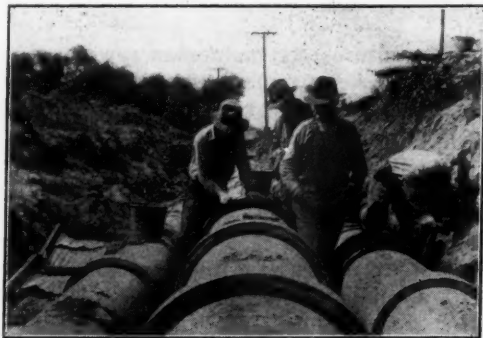
Currie Engineering Company to design a new plant. The plant is now completed and in operation.

### THE SYPHON

The city intercepting sewer, a 48-inch Meier block arch sewer, terminated 6,350 feet from the proposed site of the new plant, and it was here that the work of the sewage disposal plant began. From the outfall of the intercepting sewer to the plant it was decided to run a 3-pipe line consisting of 15-inch, 18-inch and 24-inch circular concrete pipes. It was found that from the connection with the intercepting sewer to the surface of Warm creek back of the proposed site of the plant there was a fall of 44 feet. In order to deliver the sewage to the plant at an elevation at which it would flow through the treating processes by gravity, it was found to be necessary either to carry the pipes on a trestle a large part of the way or to bury them in the ground in the form of an inverted siphon. As the latter was found to be less expensive than the trestle and was a more satisfactory and much safer method of construction, it was adopted. After careful investigation, Hume spun concrete pipe impregnated with 10 per cent admixture of emulsified asphalt was adopted for the 3-pipe line. This concrete pipe



AIR-PLANE VIEW OF SAN BERNARDINO PLANT



CALKING JOINTS OF THE THREE-PIPE  
INVERTED SIPHON.



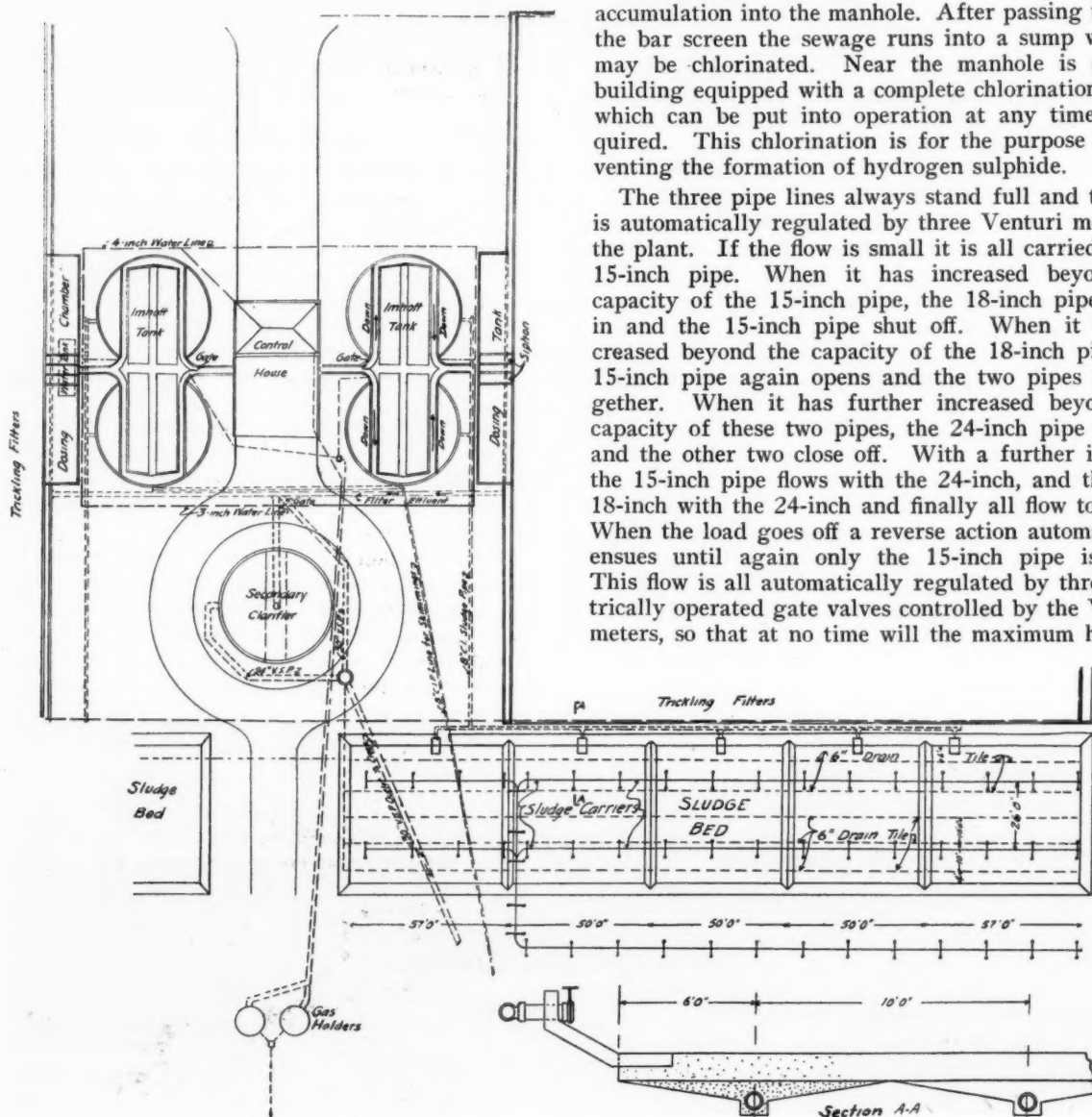
VIEW OF PLANT FROM SAN BERNARDINO-  
REDLANDS HIGHWAY.

has caulked joints and was tested to 35 pounds pressure. As was said, the syphon consists of three separate pipes, 15-inch, 18-inch, and 24-inch in diameter. These are arranged so that the amount of sewage flowing automatically selects the size of pipes required so that at no time the flow through a pipe will be less

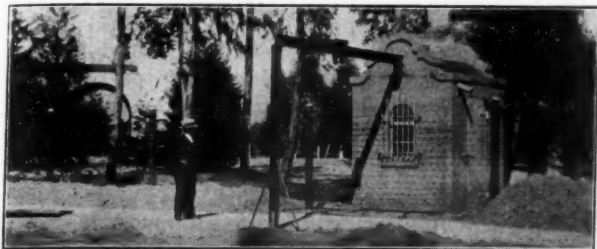
than two feet per second, which has been found to be a minimum cleansing velocity.

The sewage from the outfall sewer, before entering the syphon, passes through a 3-inch bar screen which takes out the pieces of rags and large pieces of paper, roots, sticks, etc. This bar screen is in a manhole and is cleaned out two or three times a week by raking the accumulation into the manhole. After passing through the bar screen the sewage runs into a sump where it may be chlorinated. Near the manhole is a small building equipped with a complete chlorination device which can be put into operation at any time as required. This chlorination is for the purpose of preventing the formation of hydrogen sulphide.

The three pipe lines always stand full and the flow is automatically regulated by three Venturi meters at the plant. If the flow is small it is all carried in the 15-inch pipe. When it has increased beyond the capacity of the 15-inch pipe, the 18-inch pipe is cut in and the 15-inch pipe shut off. When it has increased beyond the capacity of the 18-inch pipe, the 15-inch pipe again opens and the two pipes run together. When it has further increased beyond the capacity of these two pipes, the 24-inch pipe cuts in and the other two close off. With a further increase the 15-inch pipe flows with the 24-inch, and then the 18-inch with the 24-inch and finally all flow together. When the load goes off a reverse action automatically ensues until again only the 15-inch pipe is open. This flow is all automatically regulated by three electrically operated gate valves controlled by the Venturi meters, so that at no time will the maximum head on



PLAN OF SAN BERNARDINO SEWAGE TREATMENT PLANT.



HOUSE CONTAINING CHLORINATOR AT ENTRANCE TO INVERTED SIPHON.

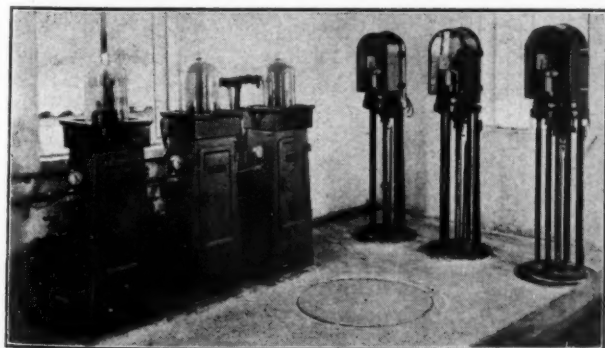
any one of the lines exceed its allowable head, and at no time will the velocity in any line be less than two feet per second.

After the sewage has passed through the Venturi meters the pipes converge into a vertical concrete "chimney" 24-inches by 30-inches and 18 feet high. The bottom of the chimney is the lowest point of the syphon lines. It is possible for considerable sediment to accumulate in this low point. To prevent this accumulation, there is provided a 3-inch air-lift pump by which the sediment that may have settled can be driven up the chimney. There is a pipe leading from the bottom of the chimney to the secondary clarifier (which will be described later) lower than any other point of the syphon. With this pipe open, the syphon pipes can be flushed and any sediment or solids that may have lodged along the line can be washed out.

#### IMHOFF TANKS

All of the sewage flows out at the top of the chimney, which is 14 feet below the flow line of the outfall sewer where it joins the inverted syphon. There are two six-foot wiers, one on either side of the top of the chimney, so that the sewage is divided into two equal parts, one-half flowing to each of the identical units of the plant. After leaving the top of the chimney, the sewage flows through connecting troughs to the Imhoff tanks. The effluent from these flows to the trickling filter beds for aeration and purification.

Each Imhoff tank unit consists of two circular concrete tanks 40 feet in diameter and 46 feet deep. The settling chambers are continuous through the two tanks and provide for a 45-minute detention period based on a maximum hourly flow at the rate of 7,000,000 gallons per day. The sludge chambers of the tank provide a capacity of 120,000 cubic feet, or 2 cubic feet per capita. The length of the flow is about 80 feet. The method of reversing the flow in the tanks is an interesting feature. As the influent enters the tank it can be turned either way by a butterfly gate. It flows with considerable fall down a



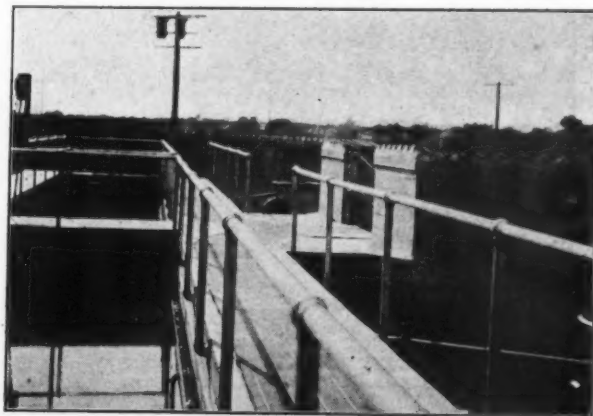
CHLORINATORS AND SIMPLEX METERS



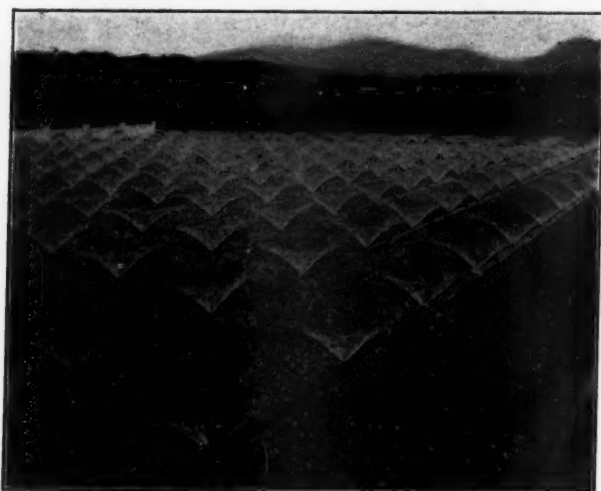
BAR SCREEN AT ENTRANCE TO INVERTED SIPHON, AND REFLECTION OF SAME.

trough, which is inside the tank, to the end of the settling chambers. It then goes through the settling chambers and then flows with quite a fall back to the middle of the tank and then off to the dosing chambers. To reverse the flow, the butterfly gate is thrown over and the sewage takes the opposite direction still with the same fall in both directions. In this arrangement there is no possibility of sediment forming in the troughs.

The sewage is drawn into the flowing-through chambers through slots in such a way that there will be no settlement in the entrance troughs, but must all take place in these chambers. A mechanical skimmer, operating at a velocity of 2 feet per minute, skims off the grease and floating solids and deposits them at the end of the tank, where they are conveyed through an 8-inch cast-iron pipe to a trench at the rear of the plant, where they are buried. There are four skimmers, each operating from the middle of the settling chamber to the end and back. They are started by a push button and when they reach the end of the



TOP OF IMHOFF TANKS, SHOWING COVERED TROUGH TO DOSING TANKS.



TRICKLING FILTER BED WITH NOZZLES IN ACTION.

chamber strike a trip which stops the motor. The direction can then be reversed, when they return to the middle of the tank.

The gas from the decomposing sludge at the bottom of the Imhoff tanks is trapped off and collected in gas collectors. The gas vent areas are completely covered with concrete roofs, 12 inches below the water line, so that the gas is all diverted into the 4-foot gas collectors. The gas collectors have artificial water seals so designed that the gas pressure can be varied from 4 to 10 inches of water. The gas is piped from the collectors to two 750-ft. capacity lift-type gas holders. From the gas holders it is piped back to the control house, where it is used to operate a 40-horsepower gas engine direct connected to a 28 kva, 50-cycle, 3-phase generator, which provides all power and lighting for the plant.

#### SPRINKLING FILTERS

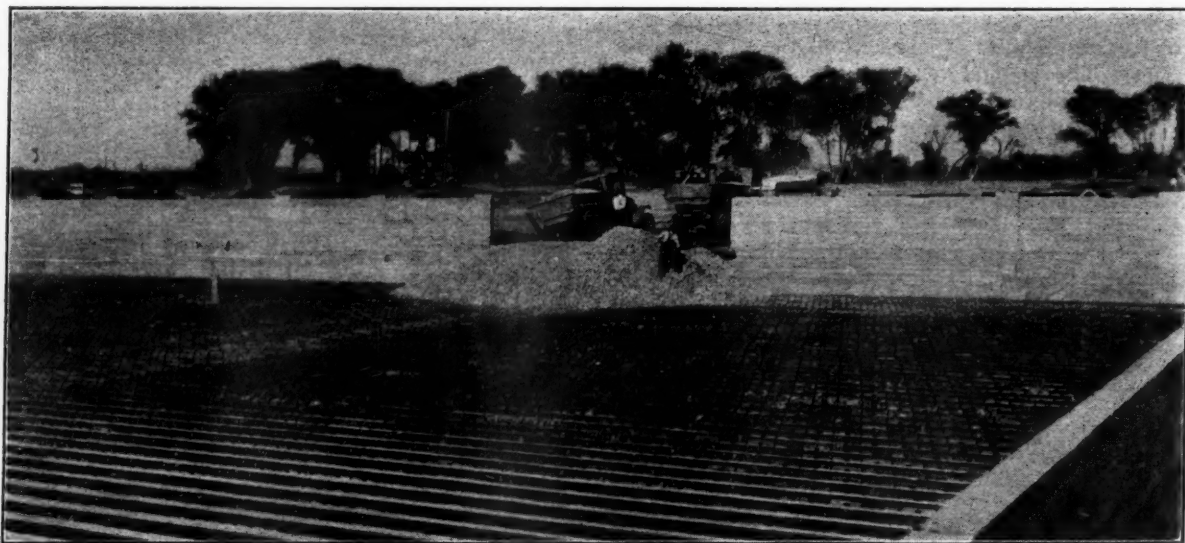
The clarified sewage flowing from the outlet of the Imhoff tanks goes directly to twin dosing chambers, each equipped with a 20-inch Pacific Flush Tank syphon and so interconnected that no inflow will occur during the dosing period. This allows better distribution in the filter beds. Each dosing chamber is piped to the filter beds and is connected to 250 stand-

ard Taylor  $\frac{7}{8}$  inch spray nozzles, spaced 11 feet 3 inches on centers, covering one-half of each filter bed. When one chamber is full it begins to spray on one-half of the filter bed, and the flow from the Imhoff tank is automatically changed through a syphon to the other chamber and the flow into the full chamber is shut off.

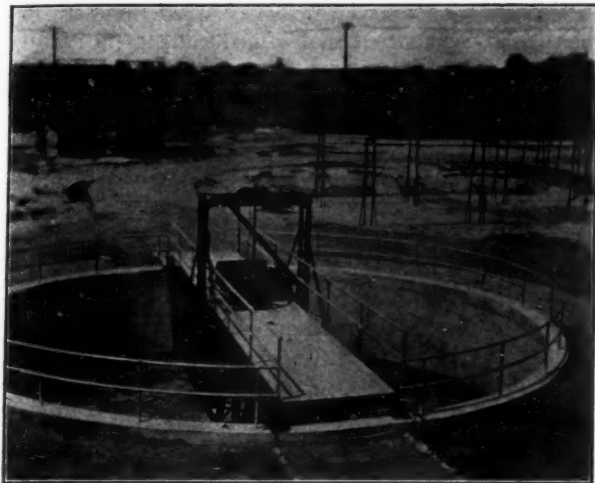
The complete filter beds for both units of the plant cover  $2\frac{1}{2}$  acres, divided into four sections. The bed of stone is 7 feet deep, composed of stone of nearly a uniform size running from  $1\frac{3}{4}$  to  $2\frac{1}{2}$  inches in diameter. The floor of the filter bed is made of 6 inches of concrete in which are imbedded Plymouth underdrain pipes laid to a 0.5 per cent grade on 24 inch centers. The underdrains are open at both ends into an inspection chamber, permitting thorough ventilation, inspection and cleaning.

The purified sewage from the underdrains is collected in long troughs and flows through an intercepting manhole into the secondary sedimentation tank, where final sedimentation takes place. As was said, provision is made for treating the sewage with chlorine where it first leaves the outfall sewer and enters the syphon pipes. Chlorine may again be introduced in the bottom of the chimney, and again in the dosing chambers after leaving the Imhoff tanks. The chlorination up to this point is for the purpose of deodorization and hydrogen sulphide control. The final application of chlorine at the inlet of the secondary sedimentation tank is for sterilization. There are four Wallace-Tiernan chlorinators. Chlorine is purchased in lots of fifteen 1-ton containers at a time, and provision is made for storing and handling these containers. This arrangement allows the chlorine to be purchased at much less than the current retail price.

The secondary sedimentation tank is 40 feet in diameter and 25 feet deep and of the Dortmund type. It is provided with a Hardinge revolving spiral clarifying equipment which provides for collection of the settled solids in the center of the bottom of the tank. This sludge may be either returned to the chimney and again go through the settling system or pumped directly to the sludge drying beds. The clarified liquor runs over the top of a circular launder around



DRAIN PIPES UNDER TRICKLING FILTER BEDS.



SECONDARY SEDIMENTATION TANK. GAS HOLDERS IN BACKGROUND.

the rim of the tank and is carried off in a 30-inch pipe directly to Warm creek.

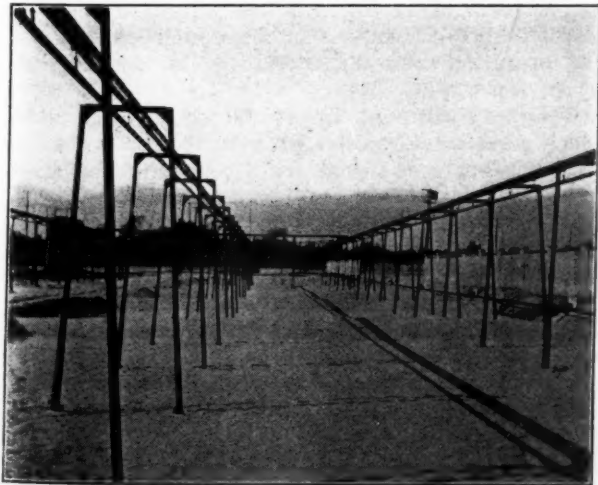
#### SLUDGE DISPOSAL

The sludge in the Imhoff tanks, after being thoroughly digested, is piped off by gravity to specially constructed sand beds with underdrains, from which the drainage water is carried in an outfall line to Warm creek. The dewatered sludge from the beds is removed by litter carriers suspended from trolleys running on a system of overhead monorail tracks. These carriers can be dumped into trucks, or the sludge may be carried to storage piles away from the beds.

#### OTHER FEATURES

In the control house basement is a Byron-Jackson motor-driven deep-well pump with automatic electric control pumping from a 300 foot well, for the fresh water supply. On the second floor is a well equipped chemical laboratory for making standard tests. The equipment includes a La Motte roulette comparator for determining the pH values and a La Motte-Enslow chlorine comparator. On the first floor, besides the Hercules gas engine generator set, is a Barnes motor-driven sludge pump.

The plant is designed for the treatment of 5,000,000 gallons of raw sewage per day. The maximum



SLUDGE BEDS, WITH OVERHEAD MONORAILS FOR REMOVING SLUDGE.

hourly load will be at the rate of 7,000,000 gallons per day, with a future population of 60,000. This plant is, as far as can be learned, the first one to include in the original construction facilities for pre-chlorination to keep down odors. Also, it is the pioneer in the use of the gas from the sewage to produce the power to operate the plant.

The relative stability of the plant effluent is, on an average, between 90 and 99, Methyl blue standard.

The operation of the plant for the first year has been turned over by the city to the Currie Engineering Company, which has contracted to furnish all the labor of operation for \$6,600. It is estimated that the total cost of operation, including chlorine and other supplies, will be about \$11,000 per year. The city has received several tentative offers from land companies for the effluent to be used as irrigation water. These offers indicate that the city will be able to derive an income from this source of \$20,000 to \$30,000 per year. The city does not anticipate any cash income from the dried sludge, as this will be turned over to the park commission to be used as fertilizer.

The cost of the plant and accessories was as follows:

Cost of plant complete without extras	\$322,827
Cost of 5000 feet of fence, with gate	\$5500
Cost of 46,000 sq. ft. asph-conc. pave.	7200
Cost of gas holders, gas engine-generator set, switchboard, piping, wiring, etc.	4800
Cost of grading, leveling and seeding.	3600
	21,100
Total cost, including extras	\$343,927
Cost of inverted syphon	\$102,603
	322,827
Cost per capita without extras	= \$5.38
	60,000
	343,927
Cost per capita with extras	= \$5.73
	60,000

There also was built, as a part of this general improvement, at a cost of \$101,623, the 48-inch intercepting sewer within the city limits to connect with the inverted syphon.

The plant was designed by and built under the direction of the Currie Engineering Company of San Bernardino, Calif. George Herz Company of San Bernardino was general contractor. All equipment and pipe was furnished by the Water Works Supply Company of Los Angeles. The Hume spun concrete pipe used in the inverted syphon was furnished by the Western Concrete Pipe Company of Los Angeles.

The plant is owned and operated by the city of San Bernardino.

#### Septic Treatment at Alliance

Alliance, Neb., population about 9,000, treats its sewage in a septic tank but is finding difficulty in disposing of the effluent without creating a nuisance. L. A. Goines, city manager, in his report for the last six months of 1928, urges that "action be taken by the city towards effecting a permanent disposal in the sand hill region southeast of the city." He considers the most feasible plan to be pumping the septic tank effluent to the top of a hill from which it can flow by gravity onto a sandy section of land.

The cost, for the last half of 1928, of "operation of

septic tank and distribution of sewage at city farm" was \$902.38. Current for pumping sewage, estimated at 12,000 k.w.h. worth \$600, was furnished free by the municipal plant. A new transformer and electrical and other equipment cost \$185, and painting and cleaning up the caretaker's house \$50; a total of \$1,737.

### Brushwood Bacteria Beds in South Africa

The Athlone sewage disposal works, which treat the sewage from the southern suburbs of the city of Cape Town, consist of sedimentation tanks of the two-story type, bacteria beds for oxidizing the tank effluent, separation of humus from the filtrate in humus tanks, and final purification by irrigation on land. The sludge chambers of the two-story tanks are designed to hold about six months' supply of sludge and are very deep. The average daily dry-weather flow reaching the works is two and three-quarter million gallons. The bacteria beds have an area of just under one acre and are filled with brushwood instead of broken stone, there being an abundance of the former growing on the farm. Although brushwood has a shorter life than broken stone, the city engineer, D. E. Lloyd-Davies, says that it is capable of treating at least three times as much tank effluent per acre, and that it will deliver a filtrate entirely free from nuisance; but he believes that the success of the beds is partly due to the South African climate.

The cost of an acre of stone beds would be approximately \$75,000 and an acre of brushwood beds costs about \$65,000. He estimates that  $3\frac{1}{2}$  acres of broken stone beds would be required for this plant, at an approximate cost of \$250,000, while one acre of the brushwood bed at \$65,000 is treating the two and three-quarter million gallons efficiently and there is indication that it will eventually treat even a higher rate of flow.

### Experiment With Dunbar Trickling Filter

Dr. W. P. Dunbar, of Hamburg, more than twenty years ago tried with success a trickling filter in which the sewage was distributed over its area not by nozzles but by graded layers of carefully selected filter stone, the top layer being as fine as coarse sand or screenings. This type of filter has received little attention in this country, but an experimental one was operated for a year during 1927 and 1928 at the Texas Engineering Experiment Station. This filter bed was 4 feet deep, and consisted of four layers of material, the bottom being of 3-in. to 6-in. stone and the top layer of 1/25 to 1/8-in.

The sewage applied was stronger than average Imhoff tank effluent of domestic sewage, and was applied at rates up to 2.0 m.g.d. per acre. The optimum rate was 1.3 m.g.d., which gave good nitrification and high dissolved oxygen in the effluent. Between this and 2.0 m.g.d. a clear effluent was produced but nitrification was incomplete and there was no dissolved oxygen but an 85% reduction in b.o.d.

After about 8 m.g.d. had been applied (about six days at optimum rate), clogging occurred, the sewage standing on the bed to a depth of 3 or 4 inches. The bed was allowed to dry out until the solids caught on the surface could be removed, requiring 36 hours in dry weather, and immediately put into service again,

the operation being continuous between these drying periods. It is reported that a uniformly good quality of effluent may be expected, even with the careless operation too often given sewage plants in small cities.

## Sinking Fund in Comparison of Sewage Treatment Costs

Relative economy of alternative plants affected by assumed period of amortization of bonds

By Charles B. Irmer

In comparing alternative methods of sewage treatment, any one of which would give satisfactory results from a sanitary point of view, the practice customary among engineers and recognized as sound is to compare the total annual costs, comprising both the operating costs and fixed charges (interest and depreciation on construction cost) of the several methods. It is apparent that the figures of total annual cost may be affected considerably by the assumptions and basic data used, important among which are the capacity of the plant and the amortization period of the bonds. The latter is the point which the writer wishes to discuss in this article.

It is required by the health authorities in most communities that, in planning sewage treatment works, the design capacity be based on an estimate of the conditions which will exist ten years in the future. If the estimate is correct, the plant will then be operating at full capacity in ten years from the date of design. It is the usual practice, however, to consider the sinking fund as applied to bonds having a life of thirty years, which therefore will have twenty years to run after the plant reaches its capacity and additional capital expenditures for expansion are therefore required. Indeed, it may be that the development of the community, change in character of its sewage, or inventions in the art of sewage treatment, may then make it advisable to scrap the old plant wholly or largely and build a larger one along different lines. In any event, it is evident that the actual useful life of the plant may fall far short of thirty years, and if this be taken into account the comparison of the economy features of plants of quite different construction and operation costs might take on an entirely different aspect.

This is illustrated by the accompanying tables which refer to alternative projects for a plant which is now being constructed for a community of about 97,000 population. Plant A is the one adopted; plant B is one which would produce comparable results, with the added feature of reducing the sludge to commercial dryness, which Plant A does not do.

The plans were drawn in 1925 for a capacity based on the estimated flow in 1935. Construction be-

Comparative Costs of Two Treatment Plants  
Average estimated flow, 17.3 m.g.d.  
Maximum estimated flow, 26.0 m.g.d.

	Plant A	Plant B
Estimated construction cost .....	\$1,902,000	\$1,151,760
Estimated annual fixed charges—		
Interest @ 5% .....	95,130	57,588
Sinking fund @ 1.783% .....	33,923	20,600
Estimated annual operating charges .....	79,150	142,571
Estimated total cost of treatment..	208,203	220,759

Table No. 2. Comparison of Plants on the Basis of Periods of Amortization of Five to Thirty Years

Assumed time of amortization years	Interest rate required	Plant A		Plant B		Total cost for assumed periods of amortization		Savings of B over A	Savings allowing two years of amortization period for construction
		Annual sinking fund charge	Total annual cost	Annual sinking fund charge	Total annual cost	Plant A	Plant B		
5 .....	18.463	\$352,000	\$526,280	\$213,000	\$413,159	\$2,631,400	\$2,065,795	\$565,605	\$692,447
10 .....	8.329	158,700	332,980	96,000	296,159	3,329,800	2,961,590	368,210	495,052
15 .....	4.994	95,300	269,580	57,500	257,659	4,043,700	3,864,885	178,815	305,657
20 .....	3.358	63,950	238,230	38,700	238,859	4,764,600	4,777,180	—12,580	114,262
25 .....	2.401	45,850	220,130	27,750	227,909	5,503,250	5,697,725	—194,475	—67,633
30 .....	1.783	33,923	208,203	20,600	220,759	6,248,400	6,622,770	—374,370	—247,528

gan in 1926 and the plant will probably be ready for operation about 1930. If it be assumed that the bonds are sold as funds for construction are required, then the capital costs involved during the construction period can be based on the interest charge of 5% on the total construction costs for two years of that period. In the case of A, this charge would be \$190,260, and for B \$115,176. If it be assumed that the bonds have had an effective life of two years at the time the plant was placed in operation, then the differences between the total costs of treatment for the two plants over the thirty-year amortization period would be as shown in the last column of table No. 2.

These tables show that the total estimated cost for B is greater than for A for an amortization period of thirty years; but is less for a period of less than twenty years if the bonds date from the start of operation of the plant, and for a period of less than twenty-five years if the bonds date from the time of construction of the plant; the saving varying in the latter case from about \$692,000 for a five-year period to about \$114,000 for a twenty-year period.

This illustrates the importance of the question: "What is the useful life of a sewage treatment plant?" To definitely and correctly answer this question is difficult if not impossible for any engineer, no matter what his competence or experience. Take for example the case of Haddonfield, N. J. According to the files of the State Health Department, plans for sand filtration beds were approved in 1901; the capacity of the plant had to be increased in 1911; in 1918 the old plant was scrapped and Imhoff tanks and sprinkling filters constructed; and in 1928 the health authorities required that the capacity again be increased. Thus in twenty-seven years two entirely different types of plant have been constructed and each of them enlarged. Had the sand filters been constructed with thirty-year bonds, the plant would have passed into discard some thirteen years before they matured.

In spite of the difficulty of assigning a probable useful life to a treatment plant, an estimate of such life is necessary to a decision between alternative plants on the basis of their relative economies. As it is the regulation with most health departments that designs for sewage treatment works be based on the estimated conditions at the end of ten years, it seems to the writer that this period should also regulate the amortization of the construction bonds. If sewage conditions develop according to the estimate, the plant will have been paid for when extensions become necessary. If it should then seem advisable to scrap the plant, the community can start again with a clean slate and not feel that, the old plant being unpaid for, they must continue to use it, possibly with some makeshift arrangement.

It would therefore appear advisable for a community to limit its capital expenditures in sewage treat-

ment structures to the lowest economical limit, arrange for the sinking fund charges to be amortized coincident with the plant reaching its designed capacity, and thus place itself in a better position to adopt new and perhaps more economical methods of sewage treatment as improvements in the art are developed.

### Blacksburg, Va., Sewage Treatment Plant

Blacksburg, Va., and the Virginia Polytechnic Institute are located in a valley at the head of Stroubles creek, a tributary of New river. As natural drainage is from the town through the grounds of the institute to the creek, the town and the institute combined to dispose of their sewage by carrying it in a sewer through the grounds of the institute and discharging it into the creek at the lower end of these grounds, first passing it through a septic tank. The history of this plant was given by R. B. H. Begg, professor of civil engineering at the institute, in a paper before the First Virginia Conference on Water and Sewage Treatment, held at Richmond, April 25 and 26th this year.

The original septic tank was outgrown in 1914, when the volume of sewage averaged 100,000 gallons a day, and an Imhoff tank and contact bed were constructed, the latter being selected instead of sprinkling filters because of the very small head available.

The plant operated well for a time, but no regular operator was appointed, the amount of sewage gradually increased until it was double that for which the plant was designed, and conditions became very bad, creating a nuisance.

Several plans for eliminating this nuisance were considered but the only practicable one seemed to be to build another plant at the same point. The plant was designed by Lee H. Williamson of Charlottesville, Va., with Fuller and McClintock of New York as consultants, and was constructed by the Haynes Construction Company of Chatham, Va. The new plant is the same type as the old, with the addition of secondary sedimentation and sludge drying beds. To prevent nuisance, the Imhoff tank and secondary sedimentation beds were covered with concrete slabs; the stone in the contact bed was carried about 6 inches above the flow line of the sewage, so that the sewage never comes to the surface; and the sludge drying beds were covered with greenhouse glass roofs. The plant is designed for an average flow of 500,000 gallons per day, or about 50 per cent in excess of the present flow.

The Imhoff tank is 41 feet long. The triangular trough or settling chamber has a cross-section which gives a detention period of  $1\frac{3}{4}$  hours and an average flowing-through velocity of .38 of a foot per second. The digestion chamber has a capacity of 1.8 cubic feet per capita. In the reinforced concrete slab roof of the tank are eight gas collecting cells, from which

the gas can be carried to a convenient place and burned if it becomes offensive. The size of contact beds gives a rate of 150,000 gallons per foot of depth per acre per day, or 600,000 gallons per acre. Provision is made for chlorination if need for it should develop later. The sludge and scum from the Imhoff tank and any sludge collecting on the three secondary sedimentation beds can be drawn into a sump, whence a pump can lift it to the sludge-drying beds or back into the Imhoff tank.

#### Water and Sewerage in Ontario

In a review of activity in waterworks and sewerage in the province of Ontario during the year 1928, by A. E. Berry in the "Canadian Engineer," it is stated that more activity was shown in this field last year than in any year since before the war. The use of

deep wells as a source of the water supply has increased remarkably. At the end of the year 1928 there were a total of 251 water works systems, of which 47 derived their supply from deep wells, 70 from rivers, 53 from lakes, and 38 from springs. The number of filtration plants totalled 48, of which 6 were slow sand, 26 pressure mechanical, and 16 gravity mechanical. More than 75 per cent of the total water supplied for domestic purposes is chlorinated.

The activated sludge system continued to be the most popular method of treatment, there being 25 plants of this type either completed or under construction, which was more than twice the number of all other plants now in operation. They vary in capacity from 250,000 to 5,000,000 gallons per day, and produced very satisfactory effluents.

## Tunneling for Hetch-Hetchy Water Supply

**Aqueduct contains eighty-five miles of rock tunnel. Shafts over eight hundred feet deep. Equipment used. Large volumes of water encountered**

**By Charles W. Geiger**

From time to time during the past few years we have published articles giving a general description of the Hetch-Hetchy water supply and certain details thereof. This project will furnish four hundred million gallons of water daily to the people in the San Francisco peninsula and will develop 200,000 hydro-electric horsepower. The aqueduct for bringing water from the O'Shaughnessy dam to the Amazon reservoir in San Francisco includes 84.9 miles of tunnel and 70.3 miles of pipe line. The tunnels are divided into four main divisions known as the Mountain, Foothill, Coast Range, and Peninsula. The Mountain division is completed; the Foothill division has been practically completed and work is now under way on the Coast Range tunnels. The tunnel-driving of the Foothill division was completed December 6, 1928, and the concrete lining later. As men and equipment were released from the Foothill division they were transferred to the Coast Range division, work on which is now being carried on under C. R. Rankin as construction engineer.

#### FOOTHILL DIVISION

In driving the Foothill tunnels, the general method was to drive a section 10 feet 3 inches by 10 feet 3 inches, with an arch radius of 5 feet 1½ inches, vertical walls, and a bottom radius of 15 feet 4½ inches. After a section of this size had been completed, it was inspected to determine where the rock conditions were such as to warrant leaving the tunnel unlined. Where unlined tunnel was considered practicable, it was enlarged to a clear height of 14 feet 3 inches, arch radius of 6 feet 8 inches, and an invert radius of 20 feet 5 inches. If lining was considered necessary, the section was not enlarged. These sections gave 166.5 square feet for the unlined section and 91.67 feet for the lined section.

At the eastern end of the Foothill division considerable water was encountered issuing from water-bearing seams in amphibolite schist. It was neces-

sary to grout off these seams when they were encountered, and during the fiscal year ending June 30, 1928, 21 shut-downs were made for this purpose, causing a total loss of 65 days. The maximum amount of water encountered in these seams was 700 gallons per minute under a pressure of 380 pounds per square inch. In grouting off the seams, 2344 sacks of cement were used.

The record speed in tunneling was made by city forces (some of the work was done by them and some by contract), the average monthly progress by them being 667 feet, with 803 feet during September, although no work was done on Labor Day. The rock encountered here was Mariposa slate and some schist.

The country was very rugged and there were many interesting details connected with the construction. In order to get supplies to the contractor's camp, an aerial tramway was built by the city at Red Mountain Bar having a span of 2,295 feet across the Tuolumne river. Water pipes to this camp crossed the river at the same point, hanging from a cable which was suspended from cliff to cliff.

The tunnel construction equipment used in the Foothill division was standardized as far as was economical and practicable, the greater part of it having been salvaged from the tunnel work in the Mountain division. The standard units adopted for supplying compressed air were Laidlaw and Ingersoll-Rand horizontal cross-compound air compressors with inter-coolers between cylinders and with fly-wheel pulley, driven by short-belt drive from a 100 h.p. motor. The displacement capacity of the compressor was about 670 cubic feet of free air. Each compressor is connected to one air receiver 48 inches in diameter and 12 feet high with a capacity of 150 feet. The pipe line to the face of the tunnel was 4 inches in diameter and a smaller auxiliary receiver was generally used, cut into the pipe near the face, when the distance from the compressor to the face was more than 2500 feet.

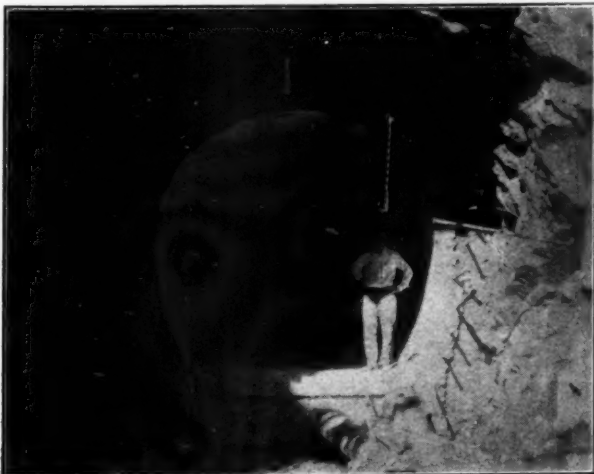


LOCOMOTIVE AND MUCK CAR USED ON FOOT-HILL DIVISION.

A Braun cooling tower was installed at each camp to conserve the cooling water required for the compressor. Ventilation for each heading was supplied by a Foote positive blower with a nominal capacity of 4500 cubic feet of air per minute under 20 ounces of pressure, belt driven by a 25 h.p. motor. The ventilating pipe was 24 inches in diameter in about 19-foot lengths, of 1/16-inch metal, riveted and dipped in asphalt. Blowers were fitted with four-gate systems to permit either exhausting smoke and gases from the headings, or blowing in fresh air.

Mucking machines were used in all faces. The Myers-Whaley and Conway machines, electric motor drive, with swinging shovel and conveyor belt, gave excellent results. Four, five, and six-ton General Electric storage battery locomotives were used in each heading to haul muck trains from the face of the tunnel to the shaft, or directly to dumps at portals and adits. Webb & Hackley cars of the side-dump type, of 50 to 80 cubic feet capacity, were used. The track gauge was 24 inches.

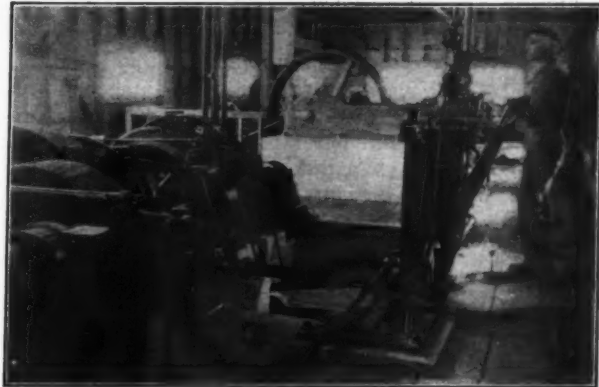
The equipment for a single-heading camp—one in which tunnel is driven in one direction only from a portal—was as follows: two air compressor units; one blower unit; one drill steel sharpening machine; one drill steel heating furnace; two mucking machines; two or three storage battery locomotives; two extra batteries for locomotives; twelve to eighteen rock cars; blacksmith and repair shops; cooling tower; and



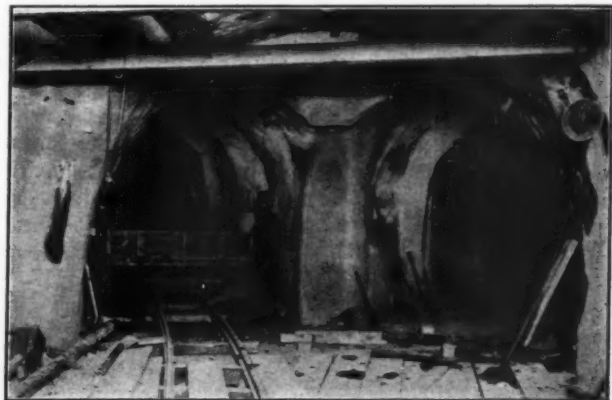
CONCRETE LINING OF TUNNEL

outdoor step-down substation, 22,000 to 440 volts. For a double-heading camp, the equipment consisted, in addition to the above, of one air compressor unit; one blower unit; one mucking machine; one or two storage battery locomotives; and eight to eighteen rock cars. In each case one locomotive was kept as a spare. A shaft camp had the same equipment as the double heading camp and in addition, a double drum geared motor driven hoist with a capacity of about 6000 pounds load hoisted at a speed of 400 to 600 feet a minute. The rock was hoisted in a self-dumping skip of 32 cubic feet capacity loaded from a rock pocket at the bottom of the shaft and dumped into a rock bin at the surface.

Besides the above, there was an outside haulage



HOISTING MACHINERY AT INDIAN CREEK SHAFT.



AT FOOT OF INDIAN CREEK SHAFT, 304 FEET DEEP.

equipment at three of the camps, consisting of one or two gasoline locomotives and Western dump cars.

#### COAST RANGE DIVISION

The headquarters for the Coast Range division were located at Livermore, on a 6-acre tract of land leased from the Southern Pacific company. Here were located a material yard for storage and supplies, and a wood-working yard in which timbers for shaft construction were framed ready for use, and also the head frames of the shafts. A pipe dipping plant was operated for dipping and repairing all water pipe and ventilating pipe as it was transferred from the Foothill division to the Coast Range division. A 40-foot by 120-foot warehouse and a garage for the motor trucks were constructed, covered with galvanized steel covering; also a machine shop which handled all repair work on all equipment used in the division.

A considerable amount of power is required for

sinking shafts and driving tunnels, for pumping water, etc., and a careful estimate was made of the cost of purchasing energy from the Pacific Gas & Electric Co. and that of using the city's own current, tapping its transmission line from the city-owned Moccasin power house and building a transmission line along the length of the aqueduct. A comparison of the ultimate cost of power from the two sources indicated that the latter would be the more economical, and the city constructed thirty miles of transmission lines consisting of two 3-phase k.v. lines of No. 2 and No. 4 seven-strand copper wire on cedar poles, for furnishing current to the several shafts and portals. At shafts the installed capacity of power transformers is 600 k.v.a., and at portal camps 300 k.v.a.

One of the shafts known as Mitchell shaft is approximately 804 feet deep, in hard schist which is badly shattered and cut by numerous seams of quartz. In the first 150 feet of depth, water was encountered which required grouting to cut off the flow before proceeding with sinking, but this flow diminished as the shaft deepened. At a depth of 425 feet a concrete ring was built around the shaft to collect the water and lead it to a small reservoir, from which it was pumped to the surface by a motor-operated double-acting plunger pump set in a concrete lined station. Water encountered in sinking was lifted by air-operated sinker pumps to this reservoir. At a depth of 475 feet, swelling ground in the vicinity of the pump station required placing a reinforced concrete lining in 45 feet of the shaft.

In the Mocho shaft, which was 818 feet deep, considerable water and small amounts of gas were encountered. This shaft was timbered throughout with 8 by 8 and 10 by 10 timbers with continuous lagging. At a depth of 460 feet, where the ground was particularly heavy, the timbers showed evidence of crushing and it was necessary to line 44 feet of the shaft with reinforced concrete lining. A pump sump was excavated at a depth of 455 feet, from which an electrically driven pump raised the water to the sur-

face. All other pumping was done by air-operated sinking pumps.

The Valle shaft was approximately 370 feet deep, in fairly soft, blocky sandstone, and showed little water in the first 100 feet; but at that depth the shaft penetrated rock with open seams carrying a large flow of water which necessitated grouting before sinking could be resumed.

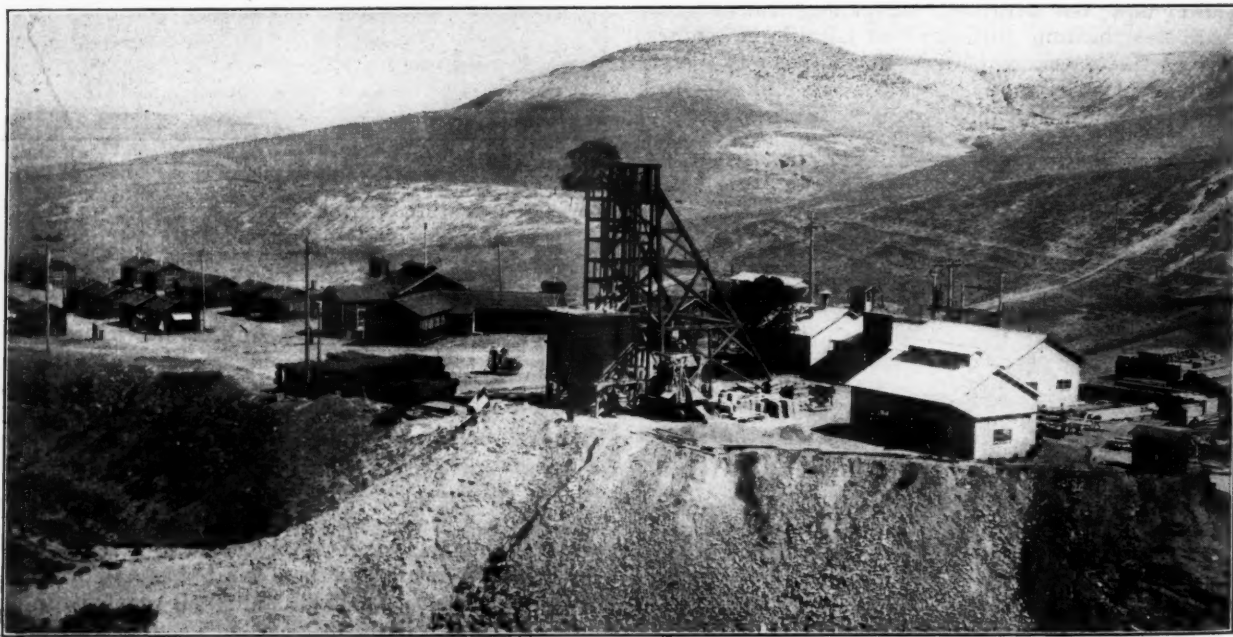
Below that depth grouting was utilized continuously. Seven two-inch pilot holes, drilled to a depth of 36 feet below the bottom of the shaft, were filled to refusal under 100 pounds air pressure with cement grout, thus shutting off what would have been large flows of water. The shaft was timbered throughout with 8 by 8 timbers and solid lagging.

Reinforced gunite lining was applied to all of the Indian Creek shaft, 304 feet deep, following closely behind the excavation, which precluded the necessity of using timber. The ground encountered was gravel embedded in firm clay which on exposure slakes and swells so that timber cannot be considered safe to hold the ground for any considerable length of time.

About 650 men are employed on the Coast Range division and something over two miles of tunnel have been driven up to the present time. In about two years the city will begin laying a 47-mile pipe line across San Joaquin valley so that it may be completed at the same time as the Coast Range tunnels.

#### Laying Iron Pipe in Rock Cuts

The cast-iron pipe forming the Elan aqueduct bringing water to Birmingham, England, was laid for a considerable length in rock trenches. In laying the pipe, the rock was taken out from 6 to 9 inches below the required level and the space filled up with any soft soil available and the pipe bedded in this. In many cases where this was done, the pipes were laid at steep gradients and in ground with a steep cross-slope. There is little doubt that under these conditions the pipe trench became a collecting drain for subsoil water and possibly surface water, and the flow



THOMAS SHAFT, COAST RANGE DIVISION, 351 FEET DEEP.

of this water along the bottom of the rock trench quickly removed the soft bedding and allowed the pipes to settle on to the rock. Quite a number of broken pipes were discovered in such localities, and the practice was therefore adopted of setting all pipe in concrete in the bottom of rock trenches.

## Water for Fire Protection

A paper on the subject of "Municipal Water Works Systems and Public Fire Protection," read before the Missouri Valley section of the American Water Works Association by Clarence E. Goldsmith, assistant chief engineer of the National Board of Fire Underwriters, gives a very complete discussion of the various points entering into the subject and contains a number of ideas and figures of special interest to the designing engineer, some of which are presented below in abstracts of parts of the paper.

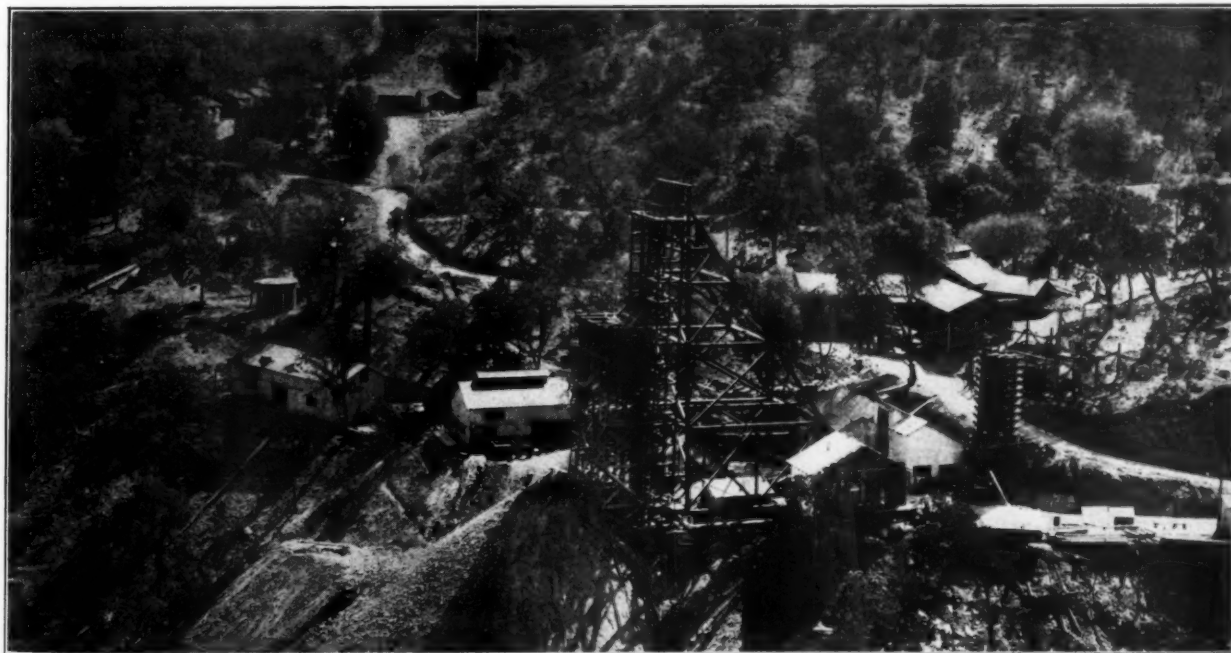
Speaking of the quantity necessary for fire flow, Mr. Goldsmith said that providing sufficient capacity in the supply works and lines was of greater relative importance for the smaller cities than for the larger. Where the population exceeds 200,000, the burden of supplying increased capacity for fire flow may be negligible. For instance, Indianapolis has an average daily consumption of about 35,000,000 gallons, and a maximum daily consumption of about 55,000,000 gallons. The fire flow required is at the rate of 23,000,000 gallons, and therefore to meet satisfactorily the fire flow requirements, the system should be able to deliver, at the time of maximum domestic daily consumption, about 78,000,000. As a matter of fact, the maximum hourly rates observed during sprinkling hours in summer are approximately 110,000,000 gallons.

In the days of the steam fire engine, it was considered more economical and reliable to raise pressures on distribution systems in order to develop sufficient pressure to deliver fire streams. The pumping plant

was then called upon to increase the pressure from say 50 pounds to 100, which automatically increased the domestic consumption  $1\frac{1}{2}$  times, requiring a draft on the steam plant three times that under ordinary domestic consumption conditions. To maintain boilers in operation to meet this demand necessitated running them much below their rated capacity, which was uneconomical. Today the gasoline-driven motor pumper has reached such a degree of perfection that its reliability approaches that of the pumps in any pumping station, whether steam or electrically driven. It can be maintained and develop sufficient pressure for fire fighting at much less cost than pressures could be raised on the water system. In addition to this advantage, the danger of bursting pipes, rupturing plumbing and blowing out connections on account of raising the pressure in the mains for fire purposes, is obviated. The present accepted practice is therefore to provide sufficient pumper capacity and not raise fire pressure.

A pressure of 75 pounds is generally considered necessary to develop small fire streams from hand hose lines, and it is desirable to be able to do this so that the first fire company responding can get into action before the fire has gained headway. Taking this into account, together with the prevailing heights of buildings, a pressure of from 60 to 75 pounds is now considered desirable domestic pressure to carry. In the larger distribution systems where pumps are located some distance from the high-value mercantile district, it is customary to maintain a pressure at the pumping station sufficient to maintain a certain predetermined pressure, say 65 pounds, in the mercantile district at all times, which necessitates raising the pump pressure during periods of maximum consumption and permits lowering it at night.

Relative to location and number of hydrants, Mr. Goldsmith said that, unfortunately, in the early days before the subject of hydrant distribution had been given sufficient study, it had been referred to as "hydrant spacing" and today the distribution is fre-



MOCHO SHAFT, COAST RANGE DIVISION, 818 FEET DEEP. COOLING TOWER AT RIGHT.

quently given in units of lineal spacing, whereas the area served is the only proper unit to use. For instance, the city blocks in the Portland, Oregon, mercantile district are 200 feet square. One hydrant at each street intersection therefore gives a satisfactory hydrant distribution of one hydrant to each 40,000 square feet, the lineal spacing in this case being 200 feet. In Salt Lake City, Utah, the blocks are approximately 700 feet square, making the area of each block 562,500 square feet; therefore 14 hydrants per block are required to give a hydrant distribution of one hydrant for each 40,000 square feet, which would require the installation of hydrants in such a manner that the lineal spacing would be 87 feet.

## Chlorination in North Carolina

### Prechlorination at Raleigh and Southern Pines increased length of filter runs and efficiency in removing bacteria. Tastes and odor removed at Siler City

The use of pre-chlorination at the filter plant of Raleigh, N. C., in the year ending September 1, 1928, was described in a paper before the North Carolina Section of the American Water Works Association by J. S. Whitener, assistant engineer of the North Carolina State Board of Health.

He stated that he believed there could be traced directly to pre-chlorination increase in length of filter runs; decrease in percentage of wash water; increase in gallons of water filtered per filter washing; decrease in total bacterial count of coagulated, filtered and disinfected water; and decrease in the B. coli index of filtered and chlorinated water. He estimated that, as compared with the year before when pre-chlorination had not been practiced, there had been 514 less filter washings which cost an average of \$1.123 each, or a total saving of \$577.22, less the cost of chlorine, \$143.75, leaving a net saving of \$433.47.

"Prior to pre-chlorination, the filters were in pretty bad condition. At the end of a run the mat would be cracked in several places near the middle of the filter and would pull away from the side walls. Hard spots would develop down in the sand and had to be broken up with a pole every time the filter was washed. This trouble has now entirely disappeared and the filter presents a smooth, unbroken surface at all times, with no hard spots in the sand.

"Enough chlorine was applied to the coagulated water to give a residual of 0.2 p.p.m. and at no time did the filter effluent show residual chlorine. Just why the application of chlorine gave these results is still unknown, but it is thought that the chlorine kills the organisms that cause contraction of the mat and those that furnish the cementing materials to the sand grains, causing hard spots. The fact that all hard spots have disappeared and the filters now present a smooth, unbroken mat accounts for the greater bacterial removal and for the clear, sparkling effluent from the filters at all times."

Mr. Whitener also described the effect of pre-chlorination at the filter plant at Southern Pines, N. C. Chlorination of the water after coagulation was tried with no beneficial result, "but when chlorine was

added to the raw water in the mixing chamber along with the alum and lime, some surprising results were noted. With the same dosage of alum and lime, the size and density of the floc was practically doubled." With a colored water such as this, this is very desirable and in this case caused a very much greater color removal in the coagulation basin. The filter runs were increased from 9 to 25 hours and the filter effluent was better than it ever had been before. Cracks and hard spots in the center of the filter were not eliminated, but it is known that they are caused by a "dead" manifold—one which has no perforation or strainer cups, from which it results that no wash water passes up through the sand over these dead spots.

At the same meeting, M. F. Trice, assistant engineer of the North Carolina State Board of Health, described the use of chlorination at Siler City in that state for the removal of taste and odors. In the spring of 1928, the water developed taste and odor which reached a maximum in May, the citizens refusing to use the water where well or spring supplies were available. Flushing mains was of little benefit. Examinations at the state laboratory showed the water to be of satisfactory sanitary quality, but this did not appease the consumers. The supply was installed in 1925 and is drawn from two wells 365 and 380 feet deep, respectively, discharging into a covered concrete reservoir and a steel elevated tank. Most of the ground water supplies of the state contain more or less iron and the fact that, when flushing the mains, the water flowing for the first few minutes contained a brown sediment suggested the presence of crenothrix. As flushing did not remove the taste and odor, it was decided to sterilize the mains with chlorine. A heavy application of chlorine was made, beginning at 11 o'clock at night to inconvenience the citizens as little as possible. A dry-feed chlorinator was attached halfway between the reservoir and the pump which supplied pressure to the distribution system. With one hydrant open in town, pumping was started with a strong chlorine application and the hydrant allowed to run until a good orthotolidine test was obtained, when this hydrant was closed and another was opened. This was continued until all hydrants in all parts of the town had been opened and the entire system saturated with chlorine. This required about five hours. The chlorine content of the water was objectionable to the consumers early the next day but it disappeared in a short time and within a week all trace of the previous taste and odor had disappeared. The superintendent is positive that flushing alone would not have remedied the trouble completely, and even if it would have been effective, it would have cost more than the application of chlorine.

### Water Supplies in Connecticut

There are in the state of Connecticut 110 water works supplying 136 communities which contain about 85% of the total population of the state. About 21% of the state population receives water that is filtered and 69% of the population receives water that has been chlorinated.

Most of the water supplies are secured from upland streams and fortunately are not affected by sewage, but it may not be many years before the lower and larger stretches of the streams may have to be drawn upon for water supplies. There are in the state 51

public sewerage systems, of which 33 include some form of treatment. With increasing use of the lower streams for municipal water supplies, pressure will be brought to require a more general adoption of sewage treatment.

## Lime for Water Treatment

A paper entitled "The Use of Lime in Water Treatment" was read before the Fourth annual conference on water purification held at the College of Engineering, West Virginia University, by Paul C. Laux, superintendent of the Williamson water works, which contains considerable information which should be useful to superintendents of water works in the use of that material.

Concerning the selection of the lime, Mr. Laux says that "the value of lime in water works operation depends on its calcium oxide content. Magnesium oxide does not react in water and is therefore as valuable as so much sand." High priced lime may contain 40 to 50 per cent of magnesium oxide, whereby only about half of it is effective for water works practice, while a cheaper lime containing a higher percentage of calcium oxide would be more effective and economical.

Quicklime for water treatment should contain about 90 per cent of water-soluble calcium oxide, whereas a hydrated lime made from such lime will contain about 80 per cent water-soluble calcium oxide. Hydrated lime costs from 25 per cent to 40 per cent more per ton than caustic lime and its effectiveness is about 75 per cent as great; but the caustic lime requires more extensive installation for satisfactory handling, gives more trouble in applying, and is more unstable and more difficult to store than hydrated lime. Softening plants and large filtration plants can effect a decided economy by purchasing caustic lime, but for smaller purification plants hydrated lime is generally preferable.

Lime is the only chemical used in filter plants that does not form a solution in water and it is therefore difficult to apply it properly. Due to the tendency to settle out of suspension, the use of dry feed machines is more satisfactory than the use of solution feed tanks. Where the latter are used, vigorous agitation is required and even then there is considerable stratification of the suspended lime unless vertical agitation is resorted to.

"The feed line for the milk of lime should be as short and direct as possible. Where turns must be made and the milk of lime has to be carried any great distance, the use of metal pipe should be avoided and fire hose or large size rubber hose should be substituted. Lime will not cling to the inner surface of hose, but will cling to any kind of metal surface unless there are no turns in the line and the fall is very steep and the distance very short. Wherever possible the feed machine or solution tank should be set directly over the point of application and the milk of lime fed directly downward. Where a turn is necessary, it should be a long sweep bend and not an ordinary tee or ell.

"Most of the difficulties of applying lime to water can be avoided by adhering to the following rules.

- 1—Use dry feed machines instead of solution feed tanks.
- 2—Put lime into the hopper in small amounts at frequent intervals.
- 3—Keep the feed line as short and straight as possible.
- 4—Where horizontal flow is necessary, use rubber hose.
- 5—Use plenty of water and large size feed lines.
- 6—Avoid all short bends and curves.

## Water Softening at Marion, O.

**Includes some of the latest developments.  
Plant operated by excess lime treatment.  
Steel used in construction where concrete  
is generally employed**

The water softening plant at Marion, Ohio, installed by the Marion Water Company with Charles P. Hoover as consultant, is believed to include some of the latest developments in water softening procedure. It was described in a paper before the Central States section of the American Water Works Association by Geo. Whysall, vice president and general manager of the company, and C. T. Whysall, his son and chemist in charge of the plant.

Steel was used in place of the more conventional concrete to a large extent throughout the plant, and Mr. Whysall stated that he believed this desirable in that changes in process can be made at little expense, whereas if concrete were used, flexibility, so needful for experimental purposes, would be practically out of the question. Moreover, the cost of the steel type with its light foundation is less than of mass concrete construction with consequent heavy foundation. It is estimated that this plant, if built along standard lines with costly foundations, would have cost at least \$250,000; whereas the estimate of the plant actually built was \$157,000 and it was built for \$147,000.

There are two chemical storage tanks which, instead of being supported on the walls of the chemical house as in most plants, rest on independent foundations. These tanks are 16 feet diameter and 30 feet high and will hold 215 tons each. They are closed over tightly at the top and at the bottom are funnel shaped, and provided with a hand-operated slide gate which permits the material to be dropped directly into the weigh hoppers beneath. The top of the weigh hoppers and the bottom of the tank are connected with a muslin tube to prevent the dust of the materials from escaping into the room. Immediately under the weigh hoppers are the Browning feeders and slakers, which are motor-driven and supplied with water to an extent which does not permit any increase in temperature due to the slaking of the lime. Lime and soda ash solutions are removed from the slakers and forced into the mixing tank by means of a water ejector.

There are two mixing tanks, 30 feet in diameter by 23 feet 8 inches high, arranged to be operated either in series or parallel, series operation having been found more satisfactory.

The water enters the mixing tank on a tangent,

thereby assisting to a considerable extent the stirring mechanism, which consists of paddles attached to the lower end of a vertical shaft and set to operate quite close to the bottom. These paddles are driven by variable-speed motors, which permit adjusting them to that speed which will produce the desired velocity of water within the tank. In practice there is but slight difference between the velocity at the center and that of the circumference of the tank, which is about 3 feet per second.

Originally the lime solution was introduced through a nozzle on the tangential feed pipe, but this method was abandoned on account of the coating and the clogging of the nozzle, which is  $2\frac{1}{2}$  inches in diameter, and there was substituted for this a 6-inch dip pipe which carries the lime solution over the top of the tank and down to a point in the zone of the feed pipe discharge. The soda ash solution also is discharged through a dip pipe which extends down about half way to the bottom of the mixing tank. Experience indicates that soda ash should be introduced at a point far enough above the lime to permit the lime reaction to become complete before the soda ash comes in contact with it. This tends toward a more uniform effluent of the second tank, as well as a better floc. The introduction of soda ash solution in the second tank was tried out but experience indicates that both lime and soda ash solution should be introduced in the first tank.

The effluent from the second mixing tank is carried through a 48-in. off-take which is supported on the bridge carrying the Dorr thickener or clarifier, delivering the effluent to the feed well of the clarifier tank. This feed well is supported from the bridge, is 30 feet in diameter and extends from above the surface of the water to a point within 10 feet of the bottom. The effluent from the clarifier is carried 60 feet through an off-take pipe, so very slowly that the floc is fairly well settled toward the bottom of the pipe by the time it reaches the feed well. The water rising around the outside of the clarifier tank is practically free of all suspended matter, the turbidity being 2 p.p.m. Around the circumference of the clarifier tank is a trough four feet deep and three feet wide with its inner wall a few inches below the level of the top edge of the tank, into which the effluent overflows and is carried to the feed well of the settling tank, which tank is equipped with a trough similar to the one in the clarifying tank, and the water moves through it in the same way as through that tank.

The water removed from the settling tank is discharged into the carbonating tank through a dip pipe extending to within 4 feet of the bottom, and from this point the water rises and passes out through an overflow to the soft water basin.

Soon after beginning operation at the plant, it was found that fine calcium carbonate particles released by carbonation were being carried through the soft water basin to the distribution system, and the practice was therefore substituted of carbonating in the feed well of the settling tank, which gives the fine suspended calcium carbonate ample time to settle. This was found to produce lower alkalinity and also made it easy to control the turbidity by adding 0.2 grain per gallon of sulphate of alumina.

The plant is operated essentially by excess lime treatment. The raw water has an average of about

60 parts of calcium carbonate and of magnesium carbonate. Sufficient lime is added to throw down all the magnesium before the soda ash is added, with the idea that by so doing all complex reactions which would occur if soda ash and lime be added at the same time are got rid of. By adding the lime just as the water enters the mixing tank, it has almost an hour (at the present rate of consumption) before the soda ash is added. Sufficient lime is added to obtain a gelatinous floc due to magnesium, which effects a reduction in the sulphates and also in the amount of soda ash necessary. The soda ash has a 15 or 20-minute mixing period in the first tank. There is about one hour mixing in the second tank also, giving a total mixing period of about two hours.

The method of treatment is described as a sort of split treatment. When feeding 3 pounds per thousand gallons of soda ash and passing 60 gallons an hour through the tank, the scale is set at 180 pounds, the speeder is started, and when the 180 are out it is shut off. The treated water is then mixed with the rest of the water which is untreated, and the effect is the same as if the whole 60,000 gallons had been treated instead of only a part of it.

The effluent from the settling basin now averages 0.5 p.p.m. turbidity where it previously ran as high as 10 to 15. By careful operation of the carbonating system it is possible to reduce the total alkalinity from an average of 55 to about 35 in the settling tank; while additional carbonating in the original carbonating tank brings the alkalinity down to an average of 30 p.p.m., or even to 23 or 25 by exercise of great care. Carbonates are reduced from 300 parts per million in the raw water to 30 after the second carbonation, and the non-carbonates from 400 to 150.

### Preventing Corrosion of Mains in Birmingham

J. W. Wilkinson, chief assistant engineer of the City of Birmingham (England) Water Dept., in a paper recently presented to the Institution of Water Engineers, gave a summary of the history of treating the water supply of that city to prevent action upon lead service pipes and corrosion of the iron and steel mains. At first, owing to the acid nature of the water and its action upon lead, it was, for a short period, treated with lime at the rate of 0.75 grain per gallon, but this later gave way to powdered chalk, which was added to the water for many years at rates varying from one to one and a half grains per gallon. The corrosion figure of the water when it reached the filters varied within wide limits but was always quite safe so far as plumbosolvency was concerned, but a certain amount of insoluble matter was deposited at various points along the aqueduct. The p H value of the water varies between a winter figure of 5.4 and a summer figure of 5.9. The chalk treatment increased this to an average of about 7.5, fluctuating between 7.3 to 8.0; the wide fluctuation probably being due to difficulty in adding the material in a regular proportion and to the suspension of treatment during week ends.

Early in 1923 silicate of soda was substituted for chalk at a rate varying between 0.55 and 1.0 grain per gallon, which treatment was continued until the end of 1926. An almost uniform p H value of 6.8 was thus obtained. While this afforded protection against

the action of water on lead, it was ineffective in preventing the corrosion of cast iron and steel mains, and, since this was the principal object in view, this treatment could not be regarded as entirely successful and moreover it was considerably more expensive than lime or chalk. It was desired to obtain a p H value of 8.0 and experiments showed that to obtain such a result would have necessitated the addition of a greater amount of silicate of soda than was considered advisable from the dietetic and economic standpoint. Beginning in 1927, silicate of soda was abandoned and return was made to treatment with hydrated lime, which is the material used today. It is added at the rate of 0.42 grain per gallon, without any breaks at week ends, and the p H value is found to vary little from a figure in the neighborhood of 8.3, and there is no trouble from corrosion of pipes.

### Accuracy of Old Water Meters

Milwaukee, Wisconsin, is almost completely metered, but the meters are owned by the consumers themselves, and can be repaired only with their consent. For this reason no periodical tests for small meters have been carried on, the department preferring to stand a slight loss by reason of under-registration of the meter, rather than incur the ill-will of the public by ordering a repair on a meter that registers the major portion of the water service.

Recently a test was conducted on meters that had not been in the shop for a number of years. One hundred  $\frac{5}{8}$ -inch meters were taken at random of which the records showed no shop entry for 20 years or more. Forty-three of these showed registration of about 100,000 cubic feet and one of them as high as 500,000 cubic feet. Of these 100 meters, 36 failed to register on full flow. Of the remaining 64, 43 showed accuracy varying from 9.6% under-registration to 25.8% under-registration, down to a 1/16-inch stream; and 21 showed under-registration varying from 11.6% to 13.6% down to a  $\frac{1}{8}$ -inch stream.

### Some Meter Notes

Some interesting facts concerning accuracy and the maintenance of meters at Terre Haute, Indiana, were given in a paper before the Indiana section of the American Water Works Association by W. H. Durbin, superintendent of the Terre Haute Water Company.

Approximately 55 per cent of the meters in that city are placed in a housing at the curb line and 45 per cent in the basements. During 1927, of the 12,355 meters in service, 78 meters were found frozen, of which number 68 were in basements and 10 at the curb line.

The total maintenance cost of meters, covering labor and material, during 1927, was \$31.29 per hundred meters, based upon the average number of meters in active service. The material cost was \$10.22 and the labor cost, \$21.07.

Tests made upon meters that have been in service for a considerable number of years invariably show them registering very close to 100 per cent on their removal. To compensate for the wear on the oscillating piston or disc and measuring chamber, a deposit or incrustation forms approximately equal to the wear that has taken place, and the accuracy of the meter is maintained. If all of this deposit is removed,

the meter invariably falls off two or three per cent in registration. "The question therefore arises, should the incrustation in the measuring chamber and on the piston be removed? Is it not better to allow this material to remain so that when the meter is placed back in service, it will register approximately 100 per cent? If the incrustation is removed, the only way in which repairs can properly be made is to supply a new piston and possibly the bottom portion of the measuring chamber. The expense in such cases runs quite high and in the end have you a meter that will offer any closer registration than if this additional expense had not been incurred?" It is therefore the practice in that city, when a meter has been in service, and the test upon removal shows a registration within 2 per cent, not to clean the deposit from the measuring chamber and piston. If, however, the meter shows 97 per cent or less in its registration, the practice is to give it a complete overhauling, which usually means a new piston, the lower portion of the measuring chamber if of the oscillating type, as well as other needed repairs.

Of 1,678 meters removed and tested during the year 1927, 62.5 per cent were found correct within 2 per cent, 29.5 per cent were found stuck, including meters damaged by hot water and frozen; 0.8 per cent over-registered more than 2 per cent; and 7.2 per cent under registered more than 2 per cent.

### Finances of a Municipal Water Department

The 12th annual report of J. E. Gibson, manager and engineer of the Board of Public Works of Charleston, South Carolina, covering the operation of the municipal water department of that city, apparently indicates that the department is financed along the lines followed by well conducted private utilities, and that it pays its own expenses. Figures for 1928 show the expenditures divided under the general heads of pumping and distribution; officers, insurance, and legal and office expenses; fixed charges; and extraordinary expenses; the pumping and distribution and fixed charges being each subdivided under three sub-heads. Figures for 1928, calculated as cost per million gallons of water delivered to the distribution system, are as follows:

Operation and maintenance of mains, \$9.62; operation of plant, including fuel and purifiers, \$31.83; maintenance of machinery, buildings and filters, \$4.75; giving a total of \$46.20 for pumping and distribution. General officers, clerical assistance, insurance, legal and office expenses, \$22.35. General, pumping, and distribution, total \$68.55. Under fixed charges—sinking fund and depreciation, \$22.78; interest, bonds, loans and taxes, \$41.25; interest on surplus invested in plant, \$29.15; giving total fixed charges of \$93.18. Also extraordinary expenses involved by droughts, repaving, repairs, relocating of mains, etc., \$4.79. This gives a grand total of all expenses of \$166.52. The gross income from the sale of water for the year was \$179.90.

The total amount of water pumped to the city mains and measured by the station meter was 1,851,660,000 gallons, of which 613,220,000 was measured by domestic meters, 887,900,000 by industrial meters, leaving 350,110,000 used by unmetered consumers, fires, leakage of mains, etc. This gives 19% of unaccounted for water.

The water is filtered, and 5,170,000 gallons daily was pumped to the sedimentation basin, 5,160,000 gallons was filtered and 5,060,000 gallons was pumped to the city after filtration. The 2% not pumped represents water used for washing filters, dissolving chemicals, cleaning reservoirs and sedimentation basins, sprinkling lawns, etc.

## Parkersburg's New Water Supply

### Aerated well water replaces supply from Ohio river

Beginning in 1884, the city of Parkersburg, W. Va., obtained its water supply from the Ohio river. Shortly after 1900, typhoid fever became more or less prevalent in the city, and after considering several projects and engineering reports, what was known as the Smith system was constructed in 1911 and 1912, consisting of a manifold of pipes and strainers laid in a sand bar in the river, augmented in 1919 by a crib.

This system was not entirely satisfactory, and in 1923, John M. Rice, of Pittsburgh, recommended the construction of a rapid sand filtration plant for filtering water from the Ohio river. The estimate showed that the filtered river supply would be less expensive both in first cost and annual charges than a well supply; but the citizens objected to the continued use of the river as a source of supply and defeated a bond issue for a filtered supply in 1924 and again in 1925.

In 1926 three wells were drilled by the Layne-Atlantic Co., and the water from them used to augment the river supply. Early in January, 1927, the firm of Morris Knowles, Inc., was engaged to investigate and report upon an additional supply, taking into consideration the general desire for a well supply. The firm submitted a report in March of that year recommending 25 wells to insure a supply of 6,000,000 gallons per day, which was considered to be the maximum requirement of the anticipated future population, the average demand of which would be about 4,000,000 gallons per day. The new supply was described by M. G. Mansfield and F. C. Foote, of the Morris Knowles Company, in a paper before the fourth annual conference on water purification at the West Virginia College of Engineering.

The estimated cost of a well supply to yield 6,000,000 gallons per day, including an iron removal plant, as well as the additional land required for the wells, was \$400,000, while the estimated cost of a filtration plant was \$300,000, both estimates including a new high-lift pump. A comparison of the estimated annual operating charges indicated that the filtration plant would cost less than the other; but the well supply was more flexible as to expansion than the filter supply, and it was possible that less than the 25 wells would be required, certainly for the immediate future. These considerations and the decided preference of the citizens for the well supply resulted in the adoption of this plan.

The plant constructed consists of 9 drilled wells in addition to the three sunk in 1926, ranging in depth from 51 to 61 feet below the surface of the ground.

With one exception, the wells are located in a single row extending for a distance of about 3,200 feet along the river bank and 15 to 25 feet back from its top. These discharge into a pipe ranging in diameter from 16 inches to 24 inches leading to a carbon dioxide removal plant, which consists of an aerator slab with spray nozzles, a mixing chamber, clear water reservoir, and pump room for the motor-driven pumping equipment. The wells are what is generally known as a Layne patent gravel wall well, consisting of a 38-inch outer casing inside of which is an 18-inch pipe carrying at its lower end a screen 10 feet long, flared out at the bottom to a diameter of 30 inches. The 38-inch steel casings extend above the ground to an elevation approximately  $3\frac{1}{2}$  feet above the maximum high water level of 1913.

A 12-inch reinforced concrete slab 12 feet square was placed four feet below the surface of the ground, and supports a reinforced concrete wall or tower 10 inches thick surrounding the casing and extending to its top. On top of each concrete wall is placed a reinforced slab 5 inches thick and 8 feet square which forms the floor of the pump house. In each of these pump houses is a vertical electric motor which operates a Layne-Bowler vertical centrifugal pump. The pump bowls range from 12 to 15 inches diameter, according to the yield which was determined by test for each individual well. Nine of the pumps are two-stage and the other three single-stage. Nine of the motors are 25 h.p., two are 20 h.p., and one is 40 h.p.

A continuous pumping test running for two weeks indicated that the 12 wells would yield an average slightly in excess of 6,000,000 gallons per day in dry weather. Individual wells yielded from 200 gallons per minute up to as high as 850 gallons per minute. When pumped continuously for five days, the wells showed a draw-down ranging from 19.1 feet to 23.1 feet, this being practically the maximum possible in each case. During the conduct of the test, the water level in the river was about 7 feet higher than the elevation of the water in the wells before pumping. The cone of influence of the various wells slightly overlapped, one well causing a draw-down on an adjacent well of about two feet.

Analysis of the well water showed it to be generally satisfactory from a sanitary standpoint but the free carbon dioxide was 27 p.p.m., the total solids 250 p.p.m. and the total hardness 167 p.p.m.; the sulphate content was 27 p.p.m. and the hydrogen ion concentration at the neutral point 7.0. Analyses have shown the presence of B coli in some of the wells, which was probably due to pollution during the installation of the wells and it is expected this will disappear after a reasonable period of use.

A small experimental aerator and sand filter were constructed and determinations of iron and CO<sub>2</sub> made upon the raw and the aerated, settled and filtered waters. This plant indicated that the free carbon dioxide varied from 50 parts per million to about 65 or even 70, and the total iron varied from 0.15 to 3.0; while after aeration the CO<sub>2</sub> content varied from 13 to 16 and, after filtration, the total iron between 0.2 and 0.4. There appeared to be some question about the necessity of removing iron, and it was decided to first construct a plant primarily intended for the removal of carbon dioxide, but with provision for later adding rapid sand filter units and treatment for the removal of iron. The plant consists of an aerator,

chemical mixing chamber, clear water basin and pumping plant.

The aerator consists of a reinforced concrete slab, 81 feet 9 inches by 74 feet 8 inches outside dimensions, supported on columns, with a brick coping extending about 2½ feet above the previous maximum high water level. The slab has a slope of 1 foot from the front to a collecting trough at the building end. The 24-inch collecting main from the wells first enters the pipe gallery located below the office and then extends up to the aerator slab at the collecting end, where it branches into a 20-inch line feeding two 12-inch headers, and a 12-inch line composing the third header, the headers being cross connected at the opposite end of the slab. Four-inch laterals extend each way from the headers, spaced 10 feet on centers and terminating in 2-inch Sacramento spray nozzles set in 4-inch elbows. The nozzles, forty-two in all, are placed on a line 5 feet from the center of the headers, giving a spacing between nozzles of 10 feet. The tops of the nozzles are 5 feet above the high water level of 1913, or 64 feet above the lowest water recorded up to date. At the end of the aerator slab, a trough 6 feet deep and 2 feet wide is provided to collect the water, from which a 24-inch pipe carries the water into the pipe gallery, whence it may be distributed to either the mixing chamber or the clear water reservoir. The loss of the head through the entire aerator system is approximately 4 feet with a rate of flow of six million gallons per day.

The mixing chamber is 13 feet 7 inches by 12 feet 1 inch, with an effective depth of 22 feet. The mixing equipment consists of a vertical shaft supported at top and bottom, to which are attached two sets of paddle arms with paddles so located that the individual ones are 90 degrees apart. The shaft is driven by an electric motor mounted on the floor above. The water from the wells can be by-passed around the aerator directly into the mixing chamber and a 24-inch pipe at the bottom of the mixing chamber permits the discharge of water into the clear water reservoir, which ultimately can be used as a sedimentation basin. A dry-feed machine for applying chemicals is provided, although the present schedule of operation does not contemplate using any chemicals and at present the mixing chamber will be used to augment the storage capacity of the clear water reservoir, which has a capacity of 140,000 gallons, giving a storage of 1 hour when operating at a rate of four million gallons daily.

Under the present method of operation, water is pumped from the wells to the aerator through the 24-inch collecting main, thence passing through the mixing chamber (although not at present used as such) to the clear water well, from where it will be pumped in the distribution system by the high-lift unit. Liquid chlorine will be applied in the line from the aerator. The existing steam pump will be maintained for emergency use.

Last November, when this paper was written, the plant was only partially in operation. However, during test runs on the aerator, the free CO<sub>2</sub> content of one sample collected from seven wells before aeration was 23 p.p.m. and after aeration 7 p.p.m. The total iron content was found to be 0.64 p.p.m. before aeration and 0.26 afterwards.

The city awarded a complete contract to the Layne-

Atlantic Company of Norfolk, Va., for drilling the necessary wells and furnishing the well pumping equipment and piping. A Phelps & Sons, of Detroit, Mich., was the contractor for the construction of the carbon dioxide removal plant and the pumping station, including the necessary piping and equipment. Plans and specifications were prepared and construction supervised by Morris Knowles, Inc., of Pittsburgh, with M. A. Sloane as resident engineer. The cost of the entire new supply works, including land, wells, carbon dioxide removal plant and pumping station amounts to approximately \$292,000, which includes approximately \$45,000 spent for the three wells drilled in 1926 and 1927.

## Garbage Collection and Disposal at Flint, Michigan

**Feeding to hogs proves profitable in spite of low pork market. Details and costs of collection and feeding**

The City Engineering Department of Flint, Michigan, has charge of the collection and disposal of garbage, which is made from practically 27,000 homes on a twice a week schedule, while collections from restaurants and downtown hotels are made daily. The collection service was extended during the fiscal year ending February 28, 1929, to the most outlying sections, and regular collections were made in even those far-outlying districts where the streets were at all passable. Because of this extension and because the service is believed to be more than usually dependable, larger amounts of garbage were collected than ever before and a larger amount per capita than in any other city of which records were obtainable.

In spite of this increase, the collection was handled by the same number of trucks as were used last year and complaints were reduced to what is believed to be an absolute minimum, an average of less than 5 per day as against more than 50 per day at the beginning of the collection two years ago. A survey has been made of the entire city, making a count of the number of cans in actual use, in order to divide the garbage collection routes so that they would be as nearly as possible equal for all collectors, and in order that the department may know more accurately just how much garbage to count on next year. It was believed that the natural increase in the city's growth would necessitate adding one or two collection trucks this year.

While garbage is collected daily, tin cans and rubbish have been collected on a three weeks' schedule, which has not proved satisfactory, because the quantity of cans and refuse accumulating during this time is too great for the present truck capacity. It is planned to increase the number of collections so that the can and refuse collection will be operated on a two weeks' schedule. If this is done and the owners place their refuse and rubbish at the curb as it accumulates during the year, it is not believed that a spring intensive clean-up campaign will be necessary.

During the year there were eleven 1-ton trucks collecting garbage, making an average of 40 loads per day with an average weight of 1½ tons per load. During the twelve months from March 1, 1928, to March 1, 1929, 18,720 tons of garbage were hauled to

the farm, the average amount of garbage per capita per day being 0.8 lb. and the average amount per house per day 4.2 lbs. The total cost of collecting garbage for the fiscal year was \$78,356, giving a cost of \$4.185 for collection per ton, and the total cost of hauling 12 miles to the farm was \$13,928 or 74.4c per ton. The total cost of disposal (farm expenses) was \$28,426 or \$1.518 per ton of garbage. This gives a total cost of collecting, hauling and disposal of \$6.447 per ton.

Hogs were purchased at a cost of \$104,084 and sold for \$153,924, giving a profit of \$49,840. In addition, \$565 was received from the sale of bones, giving a total profit of \$50,405. This is equivalent to \$2.70 per ton of garbage handled, giving a net cost of collecting, disposing and hauling of the garbage of \$3.747 per ton.

On January 3, 1928, there were inventoried at the farm 3,387 pigs weighing 528,075 pounds. There were purchased during the year 866,967 pounds, and the inventory of March 1, 1929, showed 2,346 pigs weighing 410,154 pounds, while there had been sold 1,587,920 pounds. The increase in weight of pigs over the purchase weight during 1928 was 603,032 pounds. Comparing the inventory weight of January 3 with that of March 1 on the basis of 11 $\frac{1}{4}$ c. per cwt., shows \$45,414 at the former date and \$46,142 at the latter date, a slight increase of \$728, which, added to the revenue given above, would give a gross profit of something over \$51,000.

In the collection of tin cans and rubbish, six 1-ton trucks were used collecting an average of 17 loads a day from 27,884 houses, the total number of loads collected during the fiscal year having been 5,304. The total cost of this collection was \$28,924, or \$5.45 per load, or \$1.037 per house, or 6.1c per house for each collection.

It was found that the hogs consumed from 15 to 25 pounds per day, depending upon the size of the animal, and averaging very close to 20 pounds per day. The number of hogs at the farm varied from 3,387 at the March inventory to almost 7,000 during the peak around September. Over 8,000 hogs were handled through the farm during the year and over 600,000 pounds of pork were added to the weight of the hogs purchased, which is the best year that has been reported. The gross profit of over \$50,000 was made in spite of the lowest pork market for several years, averaging not much more than \$8.00 per cwt. at times.

Every effort is made to select animals properly and take care of them carefully, especially upon arrival, and in every way to reduce the loss as much as possible. However, there is considerable loss which seems to be unavoidable because of the fact that the garbage often contains glass from broken electric light bulbs, razor blades, phonograph needles, matches, etc. These articles are so small that the collectors cannot distinguish them and as a result they get by and result in hog death. If the public would appreciate the necessity of making a very careful selection of the garbage and deposit these dangerous materials with the tin cans and rubbish, it is certain that the losses would decrease materially.

Because of the fact that the plant handles two or three times as many hogs as it was designed for and because it is necessary to plan for still greater numbers, some feeding platforms of rather large areas

must be provided this year. Mr. McClure recommends this expense because it has been found that the losses from platform feeding are very much less than when the animals are fed in the open fields, and this feeding has been found to be more sanitary, as it is possible to control the odor and nuisance situation much better. It is only by controlling this nuisance that it will be possible to continue to operate the farm without complaint.

"Inasmuch as this is doubtlessly the most profitable method of garbage disposal, we believe that every effort should be made to continue this plan for disposal just as long as possible. We do not know of any other method of disposal which will show an actual cash return in the amount noted above, and we do not know of any type of disposal plant that can be salvaged without any delay, as we would be able to salvage our animals and farm property. The farm is far more valuable as farm property than when taken over and the animals can be dumped on the market on even a day's notice."

Large animals are collected by a local rendering company without charge to the city, and the small animals are picked up by special pick-up trucks and taken to the farm and buried in isolated spots which doubtless will never be used for farm or hog raising purposes.

## Incinerator at Rockville Center, New York

Rockville Center, on Long Island, N. Y., a village with a population of about 16,000, has recently completed an incinerator at a cost of about \$107,000 not including the cost of the land; and in April the village started construction of a sewer system and sewage disposal plant which will cost about \$1,800,000.

The incinerator, which has been in operation since last fall, is disposing every collection day, without any complaint from the people of the village, of from 16 to 20 tons of garbage and refuse collected in the village, and contracts were made with villages nearby for disposing of their garbage and refuse, which add 10 to 12 tons a day, making it possible to operate the plant at its full capacity of thirty tons in an eight-hour period. The consulting engineer, Cyril E. Marshall, states that an incinerator can be operated most advantageously and economically by running the plant during the 8-hour working day because the collection of garbage and refuse is made during an eight-hour period of the day, and if the plant be operated longer than that, storage is necessary, which adds to the possibility of odors. While a smaller plant would give less interest and depreciation charges, the fact that it would have to run more than 8 hours would add to the labor cost more than the saving in overhead charges.

The incinerator was built upon two acres of low land situated only a few hundred feet from residences and bordering on the new "Sunrise Highway." The stoking floor is at the level of the natural ground, about eight feet below the highway, and the charging floor about fifteen feet higher. It is proposed to reclaim the low ground in the vicinity of the incinerator by dumping the clinker from the burned garbage in the vicinity of the plant. The building has two en-

trances to the charging floor, one on the west side receiving garbage from one side of the town and the other entrance on the southside receiving it from the other side of the town. This eliminates the possibility of the blocking up of the entrance should more than one truck arrive at the same time. The charging floor is reached by two ramps at right angles to each other, which are supported on the roofs of twelve garages which are constructed in line with the two entrances. A roadway forming an approach to a ramp is built on earth fill up to the end of each line of garages. A branch from one of the ramps leads to a courtyard about 75 feet square enclosed on two sides by the garages, which drains away from the garages to the center of the court, where a catch basin is installed connected to a 12-inch drain which empties into a nearby creek. The courtyard thus affords an excellent place for washing trucks at the end of each day. All roof water, furnace cooling water, and wash water from the charging and stoking floors of the plant is piped to this drain. The garages house 12 garbage and street department trucks and equipment.

The incinerator is that known as the United States Standard Destructor, installed by the Pittsburgh-Des Moines Steel Co., and consists of two separate units each with a capacity of destroying two tons of garbage and refuse per hour. The foundations and walls of the building up to the level of the charging floor are built of reinforced concrete and the superstructure above this is of brick. The garages and the ramps also are of reinforced concrete.

The gases from the plant, after passing through a combustion chamber, pass up through a radial brick chimney, the top of which is about 100 feet above the floor of the combustion chamber.

#### **Sewerage Progress in New York State**

The Division of Sanitation of the New York State Department of Health during the one month of April approved twenty-two plans for sewage and waste disposal. Sewage disposal plans were submitted by a city, two towns, two villages, four schools and two camps; sewerage, either new systems or extensions, by nine towns and villages; and waste treatment by a laundry and a dairy.

#### **Garbage Digestion at Dunedin**

Dunedin, Fla., in 1927, tiring of the garbage dump it had tolerated until then and wishing something less expensive than an incinerator for such a small community, tried digestion of garbage in a plant of the Beccari type. Five cells were built, believed to have a capacity of 50 tons of wet garbage per month on the basis of thirty days' retention in the cells, at a cost of \$4,500.

The cells were built of hollow tile, each fitted with three wooden trays on which the garbage was placed to a depth of two feet on each tray. Three pounds of lime were added to each 100 pounds of garbage to counteract the acids, principally due to citrus fruits, increased to five or six pounds in the fall when such fruits constituted a large part of the garbage.

Garbage was placed in one cell for seven successive days, by which time decomposition had become active and this cell was sealed and another put into use. In five more days the temperature reached about 145° C., and when it began to fall, air ports were opened to

permit aerobic bacteria to oxidize the garbage. At the end of forty days the garbage was practically dry and inodorous and occupied only 15 to 20 percent of its original bulk.

With the present amount of garbage, a cell can be filled to only about 20 percent of its capacity before it is necessary to close it, so it was decided to divide each cell into two. Also the doors were reconstructed to prevent the escape of maggots from the cells, large numbers of them having left, during the early operation, to escape the heat generated by decomposition. The plant is reported to be odorless, sanitary and economical.

## **State Highway Engineers and Contractors**

**Paragraphs from a paper before the Associated General Contractors of America by Anson Marston, Dean of Engineering, Iowa State College, president of the American Society of Civil Engineers, and for 23 years member of Iowa State Highway Commission**

"The Iowa State Highway Commission has always functioned mainly through a carefully built up engineering organization, composed of engineers appointed, paid, promoted and retained in office entirely on a merit basis, eliminating politics entirely. The commissioners themselves receive only a nominal per diem remuneration, and they function like a board of directors of a railway. During the entire 25 years since its origin the commission has employed only two chief engineers, the second promoted from the organization for merit when the first resigned to become chief of the U. S. Bureau of Public Roads. From 1913, when the commission was first given extensive authority, to 1927 only two permanent changes were made in the commission's membership, one by death and the other by voluntary resignation for business reasons.

"The commission employs several hundred engineers, the number increasing and decreasing during each year and from year to year with the actual needs of the work. All the engineer employees in the more responsible positions have had many years of highway engineering experience.

"Substantially all the commission's construction work has been done by contractors holding contracts awarded after receiving open competitive bids. In 1920, when contract prices were running wild, the commission experimented to a limited degree with the day-labor plan, but found it to cost more than contract work. Contracting is an intricate business, almost a profession, for which even a state highway commission with a great organization is not properly prepared and equipped. The Iowa State Highway Commission has saved Iowa many millions of dollars by keeping out of the contracting business."

"Strict compliance during construction with the contract plans and specifications is an absolutely essential feature of correct relations between engineers and contractors. Otherwise, bidders cannot know on what they are really bidding. The speaker submits the thought that other contractors ought to enter com-

plaint when they see the successful bidder for any contract getting away with noncompliance with the plans and specifications on which he bid. Thereby he and the engineers over him are injuring the contractors who bid for the same work in good faith.

"The contract plans and specifications should be so carefully and thoroughly prepared by the engineer as to cover every feature of the work in the clearest manner practicable, treating each item or feature completely, in one place only. Plans and specifications which are not complete, definite, just and clear mean added cost to owners in the long run."

"Guaranty clauses in contracts, such as those requiring paving contractors to guarantee paving for a term of years, are unjust to the contractor and expensive to the public. Their only justification is incompetent or corrupt engineering, the proper remedy for which is to find competent and reliable engineers."

"To permit as near an approach as practicable to the ideal conditions of award two things are essential:

"First, thoroughly competent and reliable engineers, upon whom the public can and does rely.

"Second, thoroughly competent, reliable and responsible contractors, whom the engineers and the public can trust and do trust.

"Here is where a powerful national and state organization of contractors, like the Associated General Contractors, can render indispensable service both to the contracting industry and to the public. The untrustworthy, incompetent and irresponsible contractor should be distrusted and barred, and expelled upon occasion, by the organization which is representative of contractors.

"In conclusion, the engineer's view of the untrustworthy, incompetent, irresponsible contractor is the same as his view of the untrustworthy, incompetent engineer. Both should be barred from the callings which they disgrace."

## Arizona Knows the Cost of Its Road Maintenance

By C. N. Conner\*

In Arizona, as elsewhere, there has been an increase in motor vehicle registration and also in the radius of travel by each vehicle. Based on traffic counts, the state highway department estimates that the state system carries 70 per cent of the total traffic and the county highway 30 per cent.

Practically every climatic condition exists within the borders of the state, ranging from snow-capped forested mountain summits to the arid deserts of the southern part, and from sections of the state where snow removal is a part of the maintenance to sections where snow is never known.

The United States weather reports show the following:

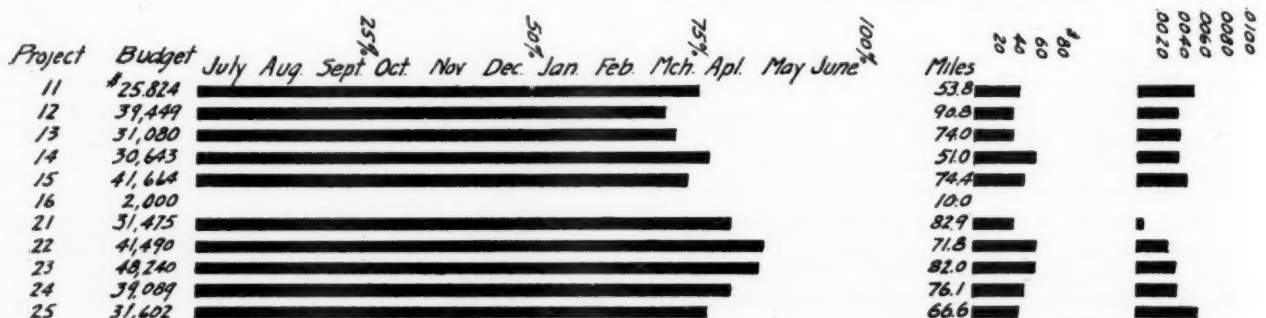
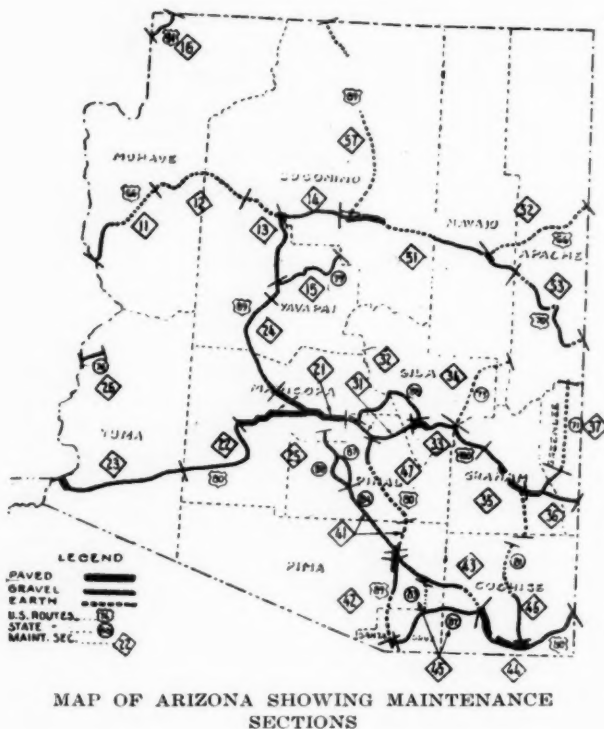
	Mean Annual Precipitation Inches	Mean Temp. High	Low	Frost	
				Latest	Earliest
Southern Arizona	10.95	113	+9	April	Oct.
Northern Arizona	16.12	107	-10	June	Sept.

The majority of the highways are surfaced with a great variety of local materials, generally classed as "gravel." During dry weather, winds are especially detrimental to these and cause a very rapid loss of the surfacing material from untreated roadways.

To maintain highways which in many instances were inadequate for the traffic demands and for which funds were not available for paving and surface treatments has required skill and foresight by the Maintenance Department. Intelligent maintenance has been made possible by close cooperation between this department and the Departments of Construction, Laboratory, Statistics and Estimating.

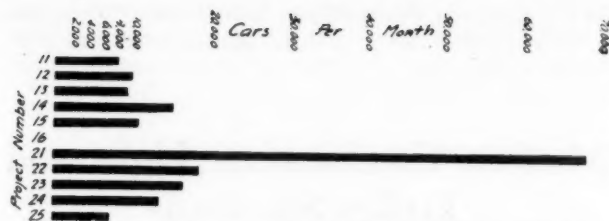
This has resulted in a knowledge of the traffic conditions and the cost of serving this traffic. The pos-

\*Engineer Executive, American Road Builders' Association.

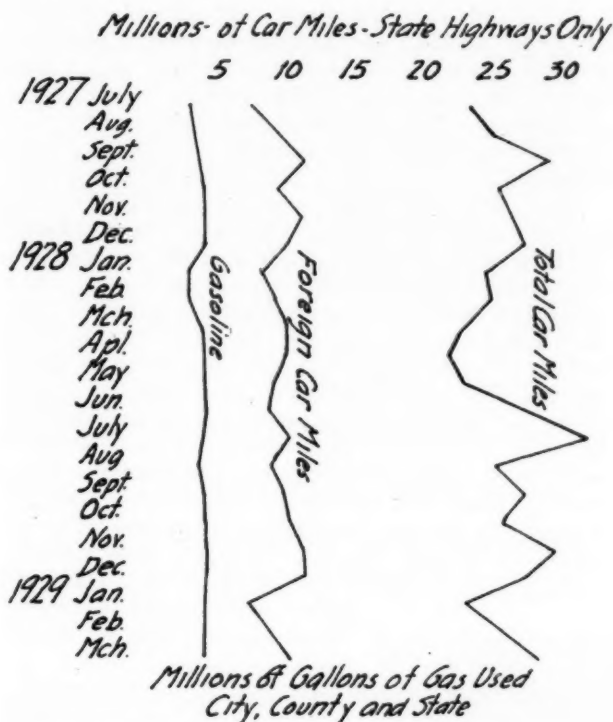


BUDGET EXPENDITURE CHART

COST OF ROAD MAINTENANCE  
Average monthly Per mile per vehicle



CARS PER MONTH ON ELEVEN OF THE PROJECTS



CAR-MILES OF TRAFFIC ON STATE HIGHWAYS AND TOTAL GASOLINE CONSUMPTION

session of such knowledge has enabled the state to budget its costs for construction and maintenance.

Each month there are prepared and distributed seven charts which show the actual conditions based on facts. The seven maintenance charts are:

1. Map of Arizona, showing maintenance sections.
2. Budget expenditures by projects, amounts and months.
3. Average monthly mile cost for each project.
4. Cost per mile per vehicle for each project.
5. Average monthly traffic for each project.
6. Traffic graph for each project by months.
7. Comparative traffic chart over a three-year period.

These charts are simple and self-explanatory. A study of them coupled with the knowledge of local materials and conditions has enabled the Arizona Maintenance Department to keep within its budget and plan intelligently its future highway program.

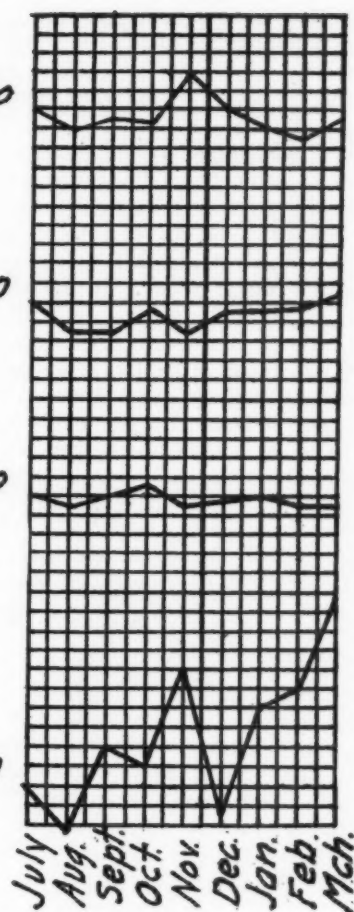
After centuries of use of the left hand side of streets for traffic, Australia has decided to follow the United States and adopt the right hand side. The change will involve an expenditure of \$2,100,000, since the government will have to change thousands of signals.

Rt. 81 4,890

Rt. 82 3,480

Rt. 83 2,640

Rt. 84 8,880



TRAFFIC GRAPH

One square equals 1,000 cars

## Sacked Concrete for Bank Protection

An embankment on the Redwood Highway in California, along the Eel river, has been subject to wash-outs at time of flood, the river rising about 25 feet at such times and carrying very heavy drift. The spring of 1928 found the roadway at this point washed out to such an extent that two cars could not pass. About 8500 cubic yards of material would be necessary to fill out the roadway to its standard width, and to prevent a repetition of the wash-out it was decided to protect the embankment; but as the season was getting late the use of slope paving was abandoned in favor of sacked concrete rip-rap, bringing up the rip-rap and the embankment together, as high water might be expected at any time.

A trench was dug about two feet deep in bed rock at the toe of the embankment and a line of sacks laid lengthwise in it, on which a second row was placed crosswise to render better stability for the footing. The remaining rows were laid lengthwise for the entire height. They were laid with each row of sacks lapping about half the width of the row below, giving a slope of about 1 to 1 to the finished wall. Slope boards were used constantly to keep the slope true, and care was necessary to keep the bags from working out of line before they had set. Two concrete mixers were set up on grade and a hopper built immediately below each mixer, where two men loaded sacks

with concrete, tied them, and shot them to the wheelers and placers below by means of troughs. From this point they were wheeled in wheelbarrows to a point of placing, the barrows running on 2-inch running boards laid on the newly placed row of sacks. The concrete was mixed comparatively wet and handling the sacks promoted a kneading action which brought a film of grout to the outside of the sacks and promoted a permanent bond between the sacks when laid. When one row was set and before the succeeding row was placed, a trench about 8 inches wide was dug immediately behind the set row and filled with green concrete. When one row had set sufficiently, the embankment was filled in behind it by means of a team and fresno. Ordinarily small grain, potato or small sugar sacks which have an open mesh were used and were tied with wire close to the concrete so that the sacks should flatten as little as possible when placed in position. The sand and gravel aggregate were hauled from a river bar by a  $1\frac{1}{2}$  cubic yard truck and were dumped close enough to the mixer so that they could be shoveled directly into skip. Mixing water was furnished by means of a pipe line and a small pump set on the river bank.

This wall was 370 feet long and 25 feet high and was "toed in" to the old ground on either end. Five hundred and fifty cubic yards of concrete were mixed and placed at a cost of \$9.50 per cubic yard. One cubic yard covers approximately 2.7 yards of surface, giving a cost of about \$3.52 per square yard of paving.

This work was designed and the construction supervised by Richard H. Wilson, district maintenance-engineer.



#### Unscrambling a Road Grader

The accompanying "before and after" pictures show work done in the shop of the State Highway Board of Georgia. The photographs were sent us through the courtesy of J. F. Coleman, maintenance engineer. The first photograph shows a grader which was struck by a train and reported a total loss. It was hauled to the Division Shop, where the shop mechanic rebuilt it in his spare time. This mechanic and the result of his work are shown in the second photograph. Nearly every member of the grader had to be straightened and realigned; but besides nuts and bolts, the only part bought for rebuilding was one hub cap.

#### England Tries Rock Asphalt From America

About the middle of May of this year there was laid in Grimsby, England, the first stretch of Kentucky rock asphalt which had ever been used in that country. It was laid on a section of Queen street, which is said to carry very heavy traffic, quite a little of it on iron tired wheels. The original macadam surface was scarified and levelled and the asphalt placed

on this as a base, laid cold and immediately rolled with a 4-ton tandem steam roller. It was estimated that this material, laid to a thickness of  $1\frac{1}{2}$  inches, would cost about \$1.25 per square yard.

## Modern Combination Light and Trolley Standards

By L. R. Need\*

A demand is evident, these days, not only for better street lighting, but also for lighting equipment, which is attractive as viewed in the day time. The old-fashioned arc lamps are practically things of the past, and in their place, attractive street lighting luminaires supporting modern electric lamps have been developed.

Many factors enter into the problem of providing adequate street lighting for modern municipalities. In the days of the arc light, little or no consideration was given to aesthetic appearance of streets, traffic conditions were of almost negligible importance, and the relation between lighting and safety was but little understood. Now not only are these features given serious consideration, but paved streets, zoning restrictions, and the modern tendency toward architectural harmony determine to some extent the type and character of the equipment for lighting modern thoroughfares. Lamps and lighting accessories have been developed for meeting the lighting requirements of all classes of streets; and for supporting these, a wide variety of ornamental luminaires is available and

many of the more enterprising municipalities have made special designs for their own use.

In too many instances, however, there is a noticeable tendency to plan an ornamental street lighting system without much regard to the other items of street furniture that may be encountered. For example, in many cases lighting standards are located in close proximity



to trolley posts and either telephone or other wire-carrying poles. This results in a multiplicity of supporting structures which have a disfiguring effect on the appearance of the street.

To accomplish this and at the same time meet the constantly increasing demands for greater strength

\*Illuminating Engineering Dept., Westinghouse Electric & Mfg. Co.



FIG. 1—DISFIGURING EFFECT OF WIRE-CARRYING POLES IN CLOSE PROXIMITY TO LIGHTING STANDARDS

to resist accidental collisions of vehicles, combination light and trolley supporting standards have been developed recently. Their columns are of reinforced concrete construction, using crushed granite for ag-

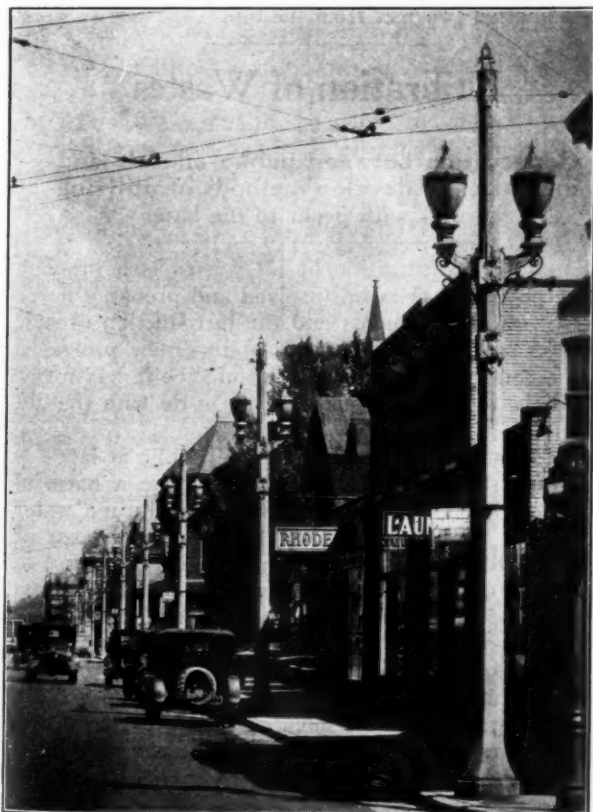


FIG. 2—COMBINATION STANDARDS DO AWAY WITH WIRE-CARRYING POLES

gregate. These standards are formed by spinning and are commonly called "hollowspun" granite standards.

In manufacturing these, cast iron molds are first prepared. A steel reinforcing structure consisting of longitudinal rods of rail steel, spirally wrapped with wire, is first placed in the mold and spaced therein by means of spacers, which are invisible in the finished product. The molds are then filled with concrete and revolved at a speed which is continuously accelerated for a definite length of time. During the spinning process, the concrete is forced away from the center of the mold by the centrifugal action caused by rotation, leaving a hole which extends through the length of the post. After spinning, all water is drained off through this hole and the post is then cured in steam

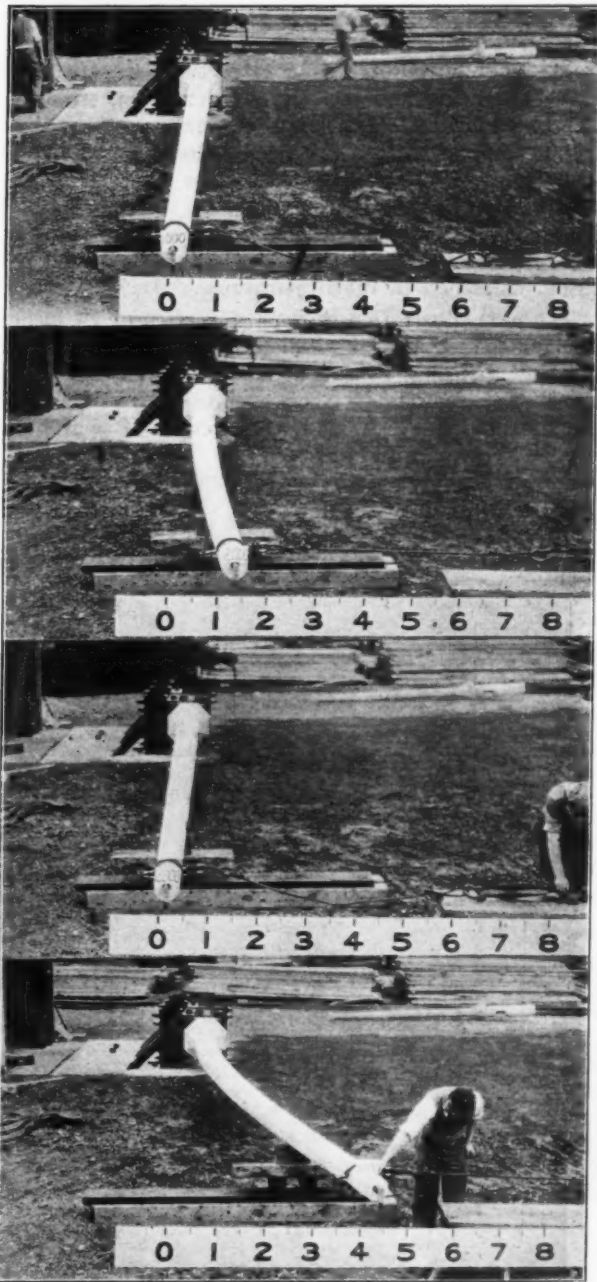


FIG. 3—FLEXURE TEST OF REINFORCED CONCRETE STANDARD 26 FEET LONG, UNDER 2,000 and 3,800 POUNDS PULL

and hydrated according to standard practice. The centrifugal action gives a strong, durable surface, which is very uniform and free of voids or pockets. By means of different aggregates, various color combinations can be obtained.

Standards of this type are designed for various loadings and heights. As a rule, provision is made for clamping ornamental brackets supporting the lighting units, the wiring accomplished by bringing cables up through the hole up the center of the post and out through openings formed in the post during manufacture. A finial is provided for the top of the post and inserts for attaching trolley eyes are firmly imbedded in the concrete near the top of the pole. A ground section several feet long is spun integral with the post so that all that is necessary for setting up a post is to prepare a hole slightly larger than the butt section and set the post in it.

To determine the strength of combined light and trolley standards of this construction, flexure tests have been made and the data on deflection, strength, etc., obtained. A 26-foot post designed for a pull of 1,000 pounds with a maximum loading of 2,000 pounds was loaded and released, the load being applied about 18 inches from the top. Under a 1,000 pound load, this post was deflected about 5½ inches, and on release, returned practically to its original position, as shown in the illustration.

The next illustration shows a deflection of 14 inches at 2,000 pound loading, which, on release, went back to about 2 inches, as shown in the third figure. Failure of the concrete in compression occurred at 3,300 pounds, under which load a deflection of nearly 52

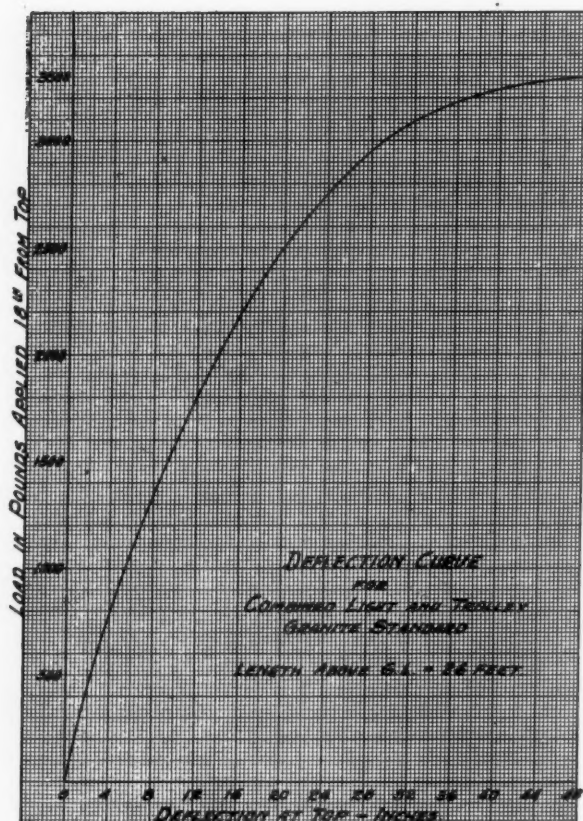


FIG. 4—DEFLECTION CURVE FOR POST SHOWN IN FIG. 3

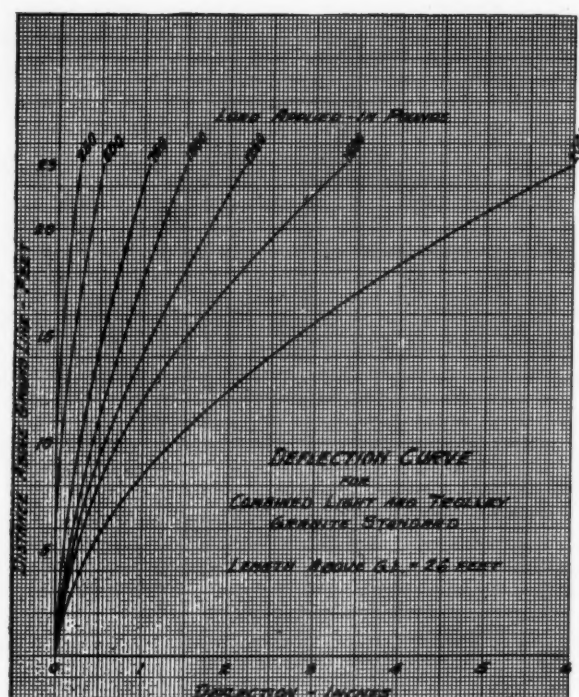


FIG. 5—DEFLECTION CURVE FOR STANDARD OF HIGHER RATING

inches was indicated, as shown in the fourth illustration.

The deflection curve for this post is shown by the diagram figure 4; while deflection curves for various loadings are illustrated in figure 5 for another standard of a higher rating. This curve shows the deflection from the ground line to the top for the various loads applied two feet from the top.

## Utilization of Wastes

### Cooperation between public officials and industries to develop methods of utilizing wastes with profit to the latter

Satisfactory utilization of all wastes is a problem which never has been fully solved and probably never will be, as developments and the introduction of new features in human progress introduce new problems. For instance, the advent of the automobile has introduced the serious problem of what to do with the old cars.

The most serious problem for the public at large is that of disposing of such wastes as have a harmful effect on human life or health, by polluting water courses or in other ways. State and local boards of health throughout the country are endeavoring to minimize the objectionable features resulting from disposal of such wastes as, for instance, the wastes from canning factories, sulphur and salt water from coal mines, etc. Elimination or minimizing of nuisances in most of these cases involves an expenditure of considerable sums of money by the industries and they naturally object to this unless convinced it is profitable or really necessary.

The ideal plan, and one toward which all are or should be working is that of discovering methods of making actually remunerative to the industries them-

selves, the disposal or conversion of wastes which become a public nuisance. We believe that in time most of these objectionable wastes will be used in some way which will at least decrease the cost of such disposal. In a number of cases millions have been made by the utilization of wastes which the industries responsible for them found it difficult to dispose of. One of the latest illustrations of this is the manufacture of celotex from bagasse (sugar cane from which the juice has been extracted). This material accumulated in piles around sugar mills; use as fuel appeared to be the only practicable disposition of it, until a process was discovered for manufacturing it into a very useful wall board. In fact, we have been informed recently that cane is now being grown in some places with the wall board as a principal product, while the molasses and sugar is only the by-product.

Charles M. Haskins, secretary, of the National Association of Waste Material Dealers, says: "Many of the large industrial corporations of the country now recognize that the proper and profitable handling of waste and by-products from manufacturing operations has a direct bearing upon the cost of their manufactured product. . . . Such concerns as the U. S. Steel Corporation, Du Pont Co., General Electric Co., Western Electric Co. and many other equally large corporations have co-operated in the establishment of a salvage division affiliated with the National Association of Waste Material Dealers, and through that means are keeping in touch with the rapid progress being made in turning waste into profits. . . . The profits of tomorrow are to be largely realized from the wastes of today." In fact, in many cases the product can be sold at cost or even less, if this is made necessary by competition, the profits of the concern being realized from the utilization of what was formerly waste which it was a problem to dispose of.

R. W. Phillips, head of the Salvage and Reclamation Department of the Du Pont Co., has stated that the material passing through that department during a period of approximately 20 years, was valued at over twenty million dollars, of which about one third was metal varying in value from iron to gold; but burlap and jute bags, rags, rope, chemical by-products, scrap wood, paper and rubber, and other materials without high value constituted a considerable part of the remainder. This statement was made at a conference held recently at the plant of the Western Electric Co. in Chicago, at which D. W. Gee, in charge of the salvage operations of that company, said: "At the present time our scrap or waste material business at the Hawthorne plant involves the handling of approximately seven million dollars worth of such material per year. This amount of money represents about 95,000,000 pounds of scrap having an average value of 7 1-3 cents per pound, which is quite comparable to the present price of sugar."

The Department of Commerce, in a pamphlet issued on "Pertinent Points about Wealth from Waste," states that a pound of paper wasted is equivalent to from one to three pounds of coal wasted; 100 pounds of soft white paper shavings would make about 80 pounds of new paper; 100 pounds of old newspaper would make about 85 pounds of new paper box board; 100 pounds of old cotton rags would make from 65 to 75 pounds of paper pulp which would make 60 to 70 pounds of paper; 100 pounds of new cotton rags would

make about 75 pounds of paper; 100 pounds of old collars, pillow cases or sheets will make about 80 pounds of new paper; woolen rags are converted into shoddy and shoddy into wool; 100 pounds of wool saved or reclaimed provides sufficient material for 25 suits of clothes; and goes on to enumerate the uses that can be made of metals of various kinds—iron, steel, zinc, lead aluminum, copper, etc.

Most waste materials have such low value per pound or ton that it is not profitable to handle them in small quantities. It is probable that, in many cities, if the city itself through the proper department would collect and dispose of the waste materials from all of the industries within its limit, it could do so at least at no loss and possibly at a profit, which the individual factories would find it impossible to do.

Probably the most serious problem for municipalities to solve, however, is the disposal of liquid wastes from canning factories, creameries, etc. One and perhaps the chief reason for this is that these industries are allowed to turn these liquids into the sewers and thus shoulder the responsibility for disposing of them onto the city; while it is not possible to so shift to the city the burden of disposal of solid matters, such as metals, rags, and other matters not readily soluble in water or carried in suspension by it. The logical solution would appear to be to refuse to permit industries to discharge liquid wastes into the sewers, and it is easy enough to say that this should be done; but where an industry has been established on the basis of so disposing of its waste liquids, such refusal to receive them might conceivably put it out of business if it should be required to go to a large expense for disposing of same, especially if its competitors in other states were not similarly required to do so. The most practicable line appears to be that along which probably the majority of the states are now working—that of seeking to co-operate with the industries in working out methods which will enable them to dispose of their wastes without either nuisance or danger to the public on the one hand, or net financial loss to themselves on the other.

## Constructing Bituminous Macadam Road in Connecticut

The method of building what is known as the Wilton road, connecting the Connecticut towns of Westport and Wilton, was described in a paper before a meeting this year of the Connecticut State Highway Inspectors by W. M. Creamer, assistant engineer of the State Highway Department. The work was let to the L. Suzio Construction Co., of Meriden, Conn. The road was 18 feet wide, of bituminous macadam, consisting of a seven-inch base course built in two layers, the first four inches deep and the second three inches deep, covered with a penetration course. Each of the courses, including the subgrade, was crowned three and a half inches, forming the arc of a circle. Where ledge rock occurred, a gravel sub-base two feet deep was placed the full width of pavement and shoulders; and the same one foot deep on poor subsoil.

The engineers required that all fills be made in parallel layers not exceeding two feet deep for the full width from the bottom with 1½:1 slopes to a 28-foot width at the top. Corrugated culverts were spe-

cified. In the mile finished the first season there was only one high fill, with an average height of 8 feet. At the low point beneath the fill a 24-inch corrugated iron culvert was placed in three 16-foot sections. The flow-line grade was staked by the inspector and the cut was carried to a depth of 6 inches below this grade for a width of two feet and the trench filled with good, clean gravel in which the pipe was placed, care being taken to fasten the collars properly to make tight joints. In making the backfill, fine material was used around the pipe and was tamped into place; all rocks were kept at least two feet from it.

After about three thousand feet of rough grading had been completed, fine grading was started. During rough grading, the grade both in cuts and on fills had been left about two inches high and the material taken out between the grade stakes was used to form temporary shoulders to bulkhead the thrust of the stone during rolling. During both rough and fine grading, the subgrade was kept well drained at all times by the use of temporary ditches. In making the fine grade, the contractor used a templet made of pine  $1\frac{1}{4}$  inches thick by 12 inches wide by 18 feet long, the bottom cut to the crown of the road, which was kept vertical by angle irons bolted to each end of the board. Fine grade was kept at least 500 feet ahead of the first layer of the base course at all times.

Sand for void filler was hauled from a local bank in 5-ton trucks and placed in stock piles about 15 feet apart, on the edge of the pavement, each pile containing about two cubic yards.

The contractor obtained broken trap rock from Bridgeport, from which point it was hauled in 5-ton trucks and distributed to the subgrade by Burch spreaders. (The engineers found it necessary to distribute a depth of five inches to obtain the required four inches after rolling.) After the first rolling of the stone, sand from the stock piles was applied, just enough being used to fill all the voids. This was rolled by a ten-ton roller operated along one edge in a direction parallel to the center line, making a trip forward and one backward, the latter overlapping the former by about one half the width of the rear roller wheels, and working successively toward the center until the edge of the inside roller wheel was just over the center line; when the same was repeated beginning at the other edge. During the rolling more sand was applied where necessary until the voids in the path of the roller were completely filled and about one quarter inch surplus remained above the stone. The base course was checked by the inspector by means of a templet and all surface irregularities corrected. If they exceeded 1 inch, they were dug out and replaced; but if not, they were scarified and rerolled.

As soon as about 400 feet of the first layer of the foundation had been rolled, the second was begun and was rolled in practically the same manner, except that water was used. The second layer also was checked by the inspector. Rolling was continued until the base did not yield under one trip of a truck of a total load of 14 tons. On the average, 16 tons of sand were used for each 100 linear feet for the first layer and 12 tons for the second layer, while 29 tons of trap rock was required for the first layer and 22 tons for the second layer.

When 3,000 linear feet of the base course had been completed, the contractor began bringing top stone,

which was required to pass a  $2\frac{1}{2}$  inch circular opening and be retained on  $1\frac{1}{2}$  inch circular opening. The top course was specified to be  $2\frac{1}{2}$  inches deep after rolling, which required  $3\frac{1}{2}$  inches loose, 24 tons of stone being used to 100 linear feet of 18-foot pavement. This stone was then rolled and checked by the template.

Four days after the base course had been completed, penetration work began. The asphalt was paid for by the state and was furnished by the Standard Oil Co. at Norwalk, which heated, loaded and applied it. The tank used was provided with 30 distributing nozzles in a row, the distance between the end nozzles being 17 feet 8 inches. The average temperature for the entire project at application was 330 degrees, and it was never below 310 degrees. The average amount used within 0.03 gallon of the mean of the specifications.— $1\frac{3}{4}$  cold gallons per square yard.

After applying the asphalt, the filler stone was spread, being shoveled from stock piles which had been placed far in advance of the penetration. Stockpiling filler stone in this way avoids hauling over the top stone, which always tends to loosen and also disturbs the base course. It was specified that the filler stone should pass through a 1-inch circular ring and be retained on a  $\frac{5}{8}$ -inch circular ring. Slightly more than enough to fill the voids in the surface was used and it was then rolled. About 4 tons of filler stone were used per 100 linear foot of road.

The seal coat was applied at an average temperature of 330 degrees and the average number of linear feet covered by each 900 gallons was 530, within .02 gallon of that provided by the specification. It was then covered with stone, which it was specified should pass through a screen having a circular opening of  $\frac{5}{8}$ -inch diameter and be retained on one with circular opening of  $\frac{3}{8}$  inch diameter. These were spread by hand from stock piles. About 3 tons per hundred linear feet was spread, which Mr. Creamer believed was a little too much and a real detriment, being carried by traffic to both edges, where it piled up and remained until the shoulders were scraped.

The problem of making laps in applying the bitumen was not an easy one to solve. Three methods were used; first, doing nothing—that is, allowing the last part of the application to remain as it fell and starting the next truck at this point, opening the valve and trusting to God that it would come out right. The results of this practice were not gratifying. Fatty spots were made at several joints. "We tried digging one out, taking out a strip 4 feet long and 18 feet wide, replacing the stone and re-applying asphalt. This was our first and last attempt. Second, by troughing. We used two 3 by 4's, each 18 feet long, with three tar papers nailed on to form a trough. This was placed over the last foot of each application. The trough was jacked up at one end so it would drain to one side. The truck would back over this trough and the valves would be opened before starting the motor. We found this to be impracticable because it was difficult to handle. The tar paper became saturated with asphalt after being used several times and could not be emptied without spilling the contents over the completed road. This merely transferred our unabsorbed spots. Third, by using a hose. A three-quarter inch armored hose was attached to the tank by a special valve. The surface

ahead of the end of the application was sprayed lightly for about three feet. The hose was then removed, the truck was started and at the same time the valve was opened. This method worked best."

About 3,600 more feet of base was completed during the fall than of wearing course. The base left over the winter received very little trueing up in the spring; it was necessary only to scarify and add sand and stone to places where depression had occurred.

## Farm-Service Roads\*

By W. E. Rosengarten†

There is a rising tide of public demand that we supplement our great paved road program with a secondary or farm-service road improvement program of such magnitude as to afford quick and substantial relief from the mud burden. If we were to complete every mile of the Federal Aid highway system it would still leave 93 per cent of our public roads outside this system. Even with the admirable work of the U. S. Bureau of Public Roads and with that of the various state highway departments, and with an outlay on the state highway systems running into billions of dollars, we have not to exceed 65,000 miles of asphalt, brick and concrete pavements. At the rate these types were built during the 1928 season it would take thirty years to finish this primary transportation system to that standard. It is quite unlikely that the state systems will ever be completed with only these higher types, but I cite this theoretical program to emphasize our dependence upon low-cost roads if we are to get the needed mileage.

Not only is that large section of our rural population whose farms do not front on the modern highway vitally concerned with the development of adequate road improvement, but a casual glance at the terrifically congested main highways in the vicinity of the cities and good sized towns should convince the most casual observer that the secondary or back-country roads must be opened up to relieve this congestion of traffic and help reduce the awful toll of human life that is arising from automobile accidents. On Sunday, when the pleasure rider from the city is out in full force, our main highways receive their peak traffic. If many of these vehicles can be enticed to travel on more inviting secondary roads, much of the congestion will be relieved. It must be evident that, if we still have almost a generation of time ahead of us in paving the primary highways with high class pavement types, it is preposterous to attempt to pave the secondary roads at the same time to the same standard. These roads must be improved quickly, effectively and cheaply and at a comparatively low cost.

This does not mean that no attention is being paid to the subject and that our highway authorities are not improving any of the secondary roads. As a matter of fact, they are building a surprisingly large mileage; but, in the aggregate, this work is tremendously short of the necessary mileage, and moreover no ratio has been set up by which to determine how much should be spent for primary roads and how much for secondary roads. This is all vitally impor-

tant, and these problems must be solved if we are to achieve the full measure of benefit in highway transport.

As a suggestion for the allotment of available money to various classes of roads, we might lay down the principle that each vehicle is entitled to have spent upon the road it travels the pro rata share of the highway funds that it supplies by gasoline or other taxes. This principle will call for expenditures to be allotted on the highways according to the traffic. For practical application, a county or state highway system might be divided into groups according to the traffic density. As a suggestion, in Group I can be placed all roads having an average daily traffic (not maximum) of more than 1,200 vehicles per day. In Group II can be placed all roads having an average traffic of from 800 to 1,200 vehicles per day. Group III could include roads having an average traffic of from 300 to 800 vehicles, while Group IV could include all roads having a traffic of less than 300 vehicles per day. This naturally calls for a traffic survey of the territory, but I believe that in order to build a highway system adequately and economically a traffic survey is essential so that the flow of traffic will be known and properly provided for. A comprehensive traffic survey would naturally classify the roads on a basis of their potential traffic rather than on the actual traffic-count prior to improvement. If the mileage in each group is obtained from a traffic survey and each is multiplied by the average potential traffic for that group, we will have the total vehicle miles of traffic on the highways of the territory for each group. The proportion of the total traffic on each group will give a basis for allotting the highway funds.

As an example, let us consider a county with 1,000 miles of highways, which has \$500,000 annually to spend on their construction. A traffic survey might class this highway system as follows:

Group	Traffic in Vehicle Miles Limits	Average	Miles in Each Group as Determined by Survey	Vehicle Miles	Percent	Subdivision of Funds
I	over 1,200	1,500	25	37,500	14	\$68,000
II	800 to 1,200	1,000	25	25,000	9	45,000
III	300 to 800	500	200	100,000	36	182,000
IV	under 300	150	750	112,500	41	205,000
Total						
			1,000	275,000	100	\$500,000

This gives a rational sub-division of the funds available, and each year particular roads from each group must be selected for improvement. The improvement required for Group I will undoubtedly be one of the A. B. C. types (asphalt, brick or concrete), which cost in the neighborhood of \$35,000 per mile. This will allow about two miles of roads of this class to be improved annually, or the complete improvement of this portion of the system in twelve years. Group II can best be served by a lower cost type of paving, such as a medium design of asphalt macadam, which may cost \$20,000 per mile and allow a little over two miles per year to be paved, or twelve years to complete this group. Records show that a medium design of penetration macadam will give excellent service under traffic of this class. In fact, this type, when built to adequate thickness of base, will carry the heaviest traffic. In Massachusetts eleven of the fifteen heaviest

\*Paper presented at the Florida Road Builders' Convention, Jacksonville, Fla.

†Traffic Engineer, The Asphalt Association

traveled roads are paved with asphalt macadam, and the traffic counts show that these roads carry from 5,000 to 10,000 vehicles per day.

When we come to Group III, averaging 500 vehicles per day, gravel or macadam with a surface-treatment or mixed-in-place coating, or sand-clay with a thin asphalt-aggregate top should be satisfactory. A recent survey of the low-cost types of roads by the Highway Research Board of the National Research Council indicates that these pavements carry from 300 to 1,500 vehicles per day. Their cost would average about \$10,000 per mile, which would allow eighteen miles per year to be paved on the typical system mentioned above. This would require some eleven years for completing the Group III roads. There are places where conditions permit a decided lowering of this average cost, for example: Florida has more than 250 miles of sand-clay bases surfaced with asphalt and slag chips, which cost for base about \$2,500 per mile and for top treatment \$2,200, or a total of \$4,700. These provide surfaces in appearance and riding qualities equal to the highest types of pavements and are satisfactorily taking traffic of 1,000 vehicles per day. The remaining roads, which carry but few vehicles, can be put in shape by draining, grading and oiling, or they might possibly be given a surfacing of top-soil, sand-clay or local materials, which could be oiled to lay the dust and assist in resisting absorption of water. The cost of improvement might average \$4,000 per mile. A total of fifty miles a year could be so treated with the available funds, which would allow the entire group to be treated in fifteen years. Such a plan must not be interpreted as precluding that flexibility which is necessary to adapt it to the needs of a given development for any one year. If, in the highest group, the apportionment allows only two miles, and a five-mile project is essential, a variation can be made for that year to permit the completion of this project, it to be compensated for by reducing the expenditure on this group in succeeding years.

It must not be considered that the improvement of the secondary roads is "temporary" and soon to be totally lost. Grading and drainage structures should be laid out and built as a lasting improvement. The base and surfacing should be laid carefully to grade with the idea that eventually they will serve as foundations for more improved surfaces, as traffic develops and the particular road moves up to a higher group. It is earnestly recommended that a survey be made of our highway systems, so that we can give due consideration to all classes of highways and thereby not over-develop one at the expense of another.

### Profit from Tree Planting on Water Sheds

Haverhill, Mass., is cashing in on the trees which its water commissioners have raised on the water sheds of the six ponds that serve as its sources of supply. Said the commission in its 1928 report:

"In the fall of 1927, an examination was made of the trees on the various water sheds, by the Division of Forestry.

"Mr. Parmenter, extension forester, reported that there were a great many trees that should be cut both for lumber and for cord wood, and that the whole operation should yield a good profit, and he recommended that the work be started as soon as possible.

No replanting will be needed as there is a wonderful white pine reproduction which will cover any areas that will be cut.

"In accordance with these recommendations, a contract was made in January, 1928, with the Hayman-Esty Lumber Company to do the necessary cutting under the provision of the Division of Forestry. They are to pay \$9.00 per thousand board feet and are to have till January 1, 1931, to complete the work."

### Glass-Covered Sludge Bed in 1915

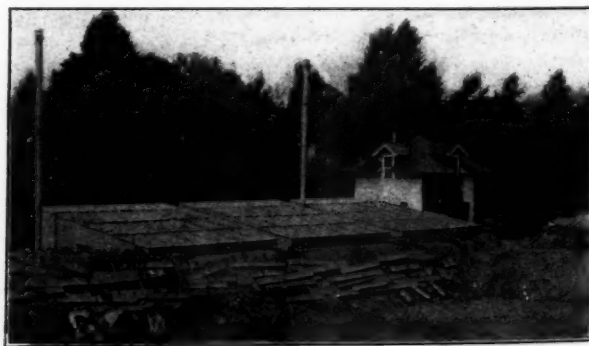
During the past four or five years, glass covers for sludge beds at sewage plants have ceased to be a novelty and have almost become standard practice under certain conditions. How far back the practice can be traced we do not know; but Fred Barns, of the Barns Engineering Co., has informed us of such a structure designed and built by Andrew J. Provost in 1915. At our request Mr. Provost (of Lederle & Provost, sanitary engineers) has furnished the following information:

The sludge beds were constructed in 1910 for the Hebrew Sheltering Guardian Society to dry sludge from plain sedimentation tanks near Pleasantville, N. Y., serving an institutional population of about 1,000. Residents located within 300 feet and in the line of the prevailing winds complained of odors when sludge was drawn, and in 1915 an attempt was made to remedy this by covering and ventilating the beds. Ordinary greenhouse glass was used (apparently laid almost flat, like hot-bed construction, to judge from the photograph) to provide higher evaporating temperature. There were three separate enclosures, one over each bed, connected to ventilating stacks. This installation resulted in substantial or entire absence of complaint.

The timber superstructures and glass frames lasted until this year, when they were replaced with a single modern type superstructure 20 by 50 feet.

The tank effluent is filtered through sand filters (the photograph shows reconstruction of the filters in 1921, after ten years of useful life), and treated with calcium hypochlorite, and the final effluent discharged into a tributary of the Saw Mill river, which is used as a source of water supply.

This plant was designed twenty-one years ago and is believed to be one of a very few still operating with high efficiency which can claim such a long life. The plant has been operated continuously under the direction of Mr. Provost's office, and its satisfactory long life is probably due to this and to the complete co-operation of the trustees and officers of the society.



GLASS-COVERED SLUDGE BEDS BUILT IN 1915

# PUBLIC WORKS

Published Monthly  
at 310 East 45th St., New York, N. Y.  
Western Office: Michigan-Ohio Building, Chicago

S. W. HUME, President J. T. MORRIS, Treasurer  
A. PRESCOTT FOLWELL, Editor  
W. A. HARDENBERGH, Associate Editor

Subscription Rates  
United States and Possessions, Mexico and Cuba.. \$3.00 year  
All other countries ..... \$4.00 year  
Single copies, 35 cents each

Change of Address  
Subscribers are requested to notify us promptly of change of address, giving both old and new addresses.

## CONTENTS

BAY SHORE HIGHWAY, SAN FRANCISCO. Illustrated .....	251
Striping California Highways .....	252
WORKING DAYS AND CLIMATIC CONDITIONS. By C. N. Conner.....	252
Timber Highway Bridges in Idaho .....	254
Pennsylvania Maintains County Bridges.....	254
Highway Expenditures by States .....	254
SAN BERNARDINO SEWAGE TREATMENT PLANT. Illustrated. By James N. Hatch.....	255
Septic Treatment at Alliance .....	259
Brushwood Bacteria Beds in South Africa.....	260
Experiment with Dunbar Trickling Filter.....	260
SINKING FUND IN COMPARISON OF SEWAGE TREATMENT COSTS. By C. B. Irmer.....	260
Blacksburg, Va., Sewage Treatment Plant.....	261
Waterworks and Sewerage in Ontario.....	262
TUNNELING FOR THE HETCH HETCHY WATER SUPPLY. Illustrated. By C. W. Geiger.....	262
Laying Cast-Iron Pipe in Rock Cuts.....	264
WATER FOR FIRE PROTECTION.....	265
CHLORINATION IN NORTH CAROLINA.....	266
Water Supplies in Connecticut .....	266
Lime for Water Treatment .....	267
WATER SOFTENING AT MARION, O. ....	267
Preventing Corrosion of Mains in Birmingham.....	268
Accuracy of Old Water Meters .....	269
Some Meter Notes .....	269
Finances of a Municipal Water Department.....	269
PARKERSBURG'S NEW WATER WORKS.....	270
GARBAGE COLLECTION AND DISPOSAL AT FLINT, MICH. ....	271
Incinerator at Rockville Center, N. Y. ....	272
Sewerage Progress in New York State.....	273
Garbage Digestion at Dunedin .....	273
STATE HIGHWAY ENGINEERS AND CONTRACTORS .....	273
ARIZONA KNOWS THE COST OF ITS ROAD MAINTENANCE. Illustrated. By C. N. Conner.....	274
Sacked Concrete for Bank Protection .....	275
Unscrambling a Road Grader. Illustrated .....	276
England Tries Rock Asphalt from America.....	276
MODERN COMBINATION LIGHT AND TROLLEY STANDARDS. Illustrated. By L. R. Need .....	276
UTILIZATION OF WASTES .....	278
CONSTRUCTING BITUMINOUS MACADAM ROAD IN CONNECTICUT .....	279
FARM SERVICE ROADS. By W. E. Rosengarten .....	281
Profit from Tree Planting on Watersheds.....	282
GLASS COVERED SLUDGE BED IN 1915. Illustrated .....	282
EDITORIAL NOTES .....	283
Highway Expenditures Will Not Decrease—Controversy Over Mississippi Flood Control.	

Prevention of Traffic Problems Better Than Cure...	284
The Engineer Defined Anew .....	284
Cornell to Teach Hotel Engineering .....	284
RECENT LEGAL DECISIONS .....	285

## Highway Expenditures Will Not Decrease

If the improvement of the roads listed in the several state highway systems continues for three years more at the rate which has been maintained for the past three years, there will be no more "unimproved" roads in these systems. From which simple calculation some have argued that expenditures on highways will then decline to nominal sums, and that road contractors and manufacturers of road-construction equipment and materials should begin to look around for other fields of endeavor and sources of profit.

There is not a chance of anything of the kind happening. In the first place, of the 302,000 miles of roads in the state systems, only about 70,000 have been improved with anything more durable than water-bound macadam or gravel; in fact, more than 40,000 miles of these "improved" state roads have been only graded and drained. Until the remaining three-fourths of the present state systems have been promoted to something more permanent than dirt, sand-clay and gravel, there will remain work to be done and billions of dollars to be spent.

In the second place, there is already a demand in many states that the state systems of highways be enlarged to include additional roads, and in several states such enlargement has already taken place. Only about ten per cent of the roads of the United States are included in the present schedules of state highways.

In the third place, there are county and township roads totaling hundreds of thousands of miles which are greatly in need of improvement and will undoubtedly receive it.

Fourthly, there are no "permanent" pavements. All wear out in time if used and deteriorate if not used. Already, although our modern pavements have been in service only a few years, more than a third of the state highway expenditures are for maintenance, repairs and renewals. Within ten years the sums required for such purposes will exceed the total amounts spent at present for highway improvement.

Fifthly, more than three-fourths of the country's mileage has as yet received no attention except such dragging and culvert construction as townships give to country roads. While these roads continue to serve only as feeders to state and county highways, they probably will not and should not be improved beyond the sand-clay or gravel stage; but even this, with the grading, draining and bridges which should precede it, will furnish abundant work for years to come. And the maintenance of these two and a half million miles will continue to demand work and funds.

No, the time is not yet in sight when our highway departments will have to exercise ingenuity and imagination to find ways to spend the gasoline taxes and automobile license fees, or the manufacturers of road machinery turn their plants into airplane factories. But there will probably be some change in the nature of road work, construction and maintenance of second class roads receiving much more attention and funds than at present.

### Controversy Over Mississippi Flood Control

Ever since the Mississippi river flood control plan was announced, there has been violent opposition to it. At the present time this opposition has reached a point where it is possible that the so-called "adopted plan" will be subjected to reconsideration and perhaps reconstruction. The Birds Point-New Madrid floodway is the present storm center. Briefly, the adopted plan proposes a set-back of the levees here, the area between the present levees and the new one, comprising the floodway, to be protected by "fuseplug levees" that will go out when the water at the Cairo gauge reaches 55 feet. The lands in the floodway total about 130,000 acres, of which about 50,000 is cultivated farm land.

Lower down the river, other channels are provided to take the peak load from the river. Before the levee system along the river reached its present degree of completeness, the river in flood passed through these parallel streams, such as the Boeuf River and Bayou Macon, and backed up into innumerable areas on both sides of the main stream.

For fifty years flowage area has been taken away from the Mississippi. Though the flood of 1927 was the most disastrous on record, the volume of water was not the greatest on record. It wrought destruction because it was confined within levees, whereas in former years it was free to back up into wide areas which formed storage, reducing the flood peaks.

The common-sense way to meet the problem is to provide means whereby the flood levels will be lowered. Raising of the levees cannot suffice in all cases. Of necessity, provision for more flowage area will take away land, usually valuable land. But in the long run, the lowering of flood levels will prove soundest and cheapest, we believe, because it is based on good engineering practice.

### Prevention of Traffic Problems Better than Cure

The advantages of preparing a city plan *now*, carefully worked out by experienced city planners, and using it rather than "filing" it in a safe deposit vault, are briefly summed up as follows in the latest report of the Regional Plan of New York and Its Environs:

"If the present bad conditions are due to lack of preventive measures in the past, then it follows that the employment of preventive measures today is necessary to prevent the further growth of bad conditions in the future. That is so with problems of traffic as well as of transit congestion.

"It would provide a startling revelation if one side of a balance sheet could be made up of the cost of maintaining street movement in New York City, in so far as it is due to the combination of overbuilding, defective distribution of uses, and ill-balanced arrangement of transport and transit terminals and facilities. These items, constituting traffic costs that a plan might have avoided, include:

- (a) Cost of a large proportion of traffic regulation.
- (b) Losses due to slowing up traffic and lack of parking facilities.
- (c) Cost of street widening and ultimately of double decking of streets.
- (d) Business losses due to restriction of traffic to one-way streets, of narrowing of sidewalks and of conversion of streets into playgrounds.
- (e) Losses in time-distance due to the large extent of blighted or sparsely-built areas.

"On the other side of the balance sheet, what are the items of cost which would have to be borne to prevent the above losses? They would probably include only two, namely:

- (a) Cost of making a plan.
- (b) Purchase of more land for streets and parks in advance of building.

Widening streets, says the report, is not necessarily a cure of congestion. "To the superficial observer the narrowness of streets or highways appears to be the sole or primary cause of congestion. Probably it is the prevalence of this view that is responsible for so much effort being directed to the widening of the highways and so little to removing the other causes of congestion. Seeing the streets congested it is natural in the absence of studious enquiry to assume that the reason they are congested is that they are not wide enough to serve the buildings fronting them together with the needs of through traffic. But it will frequently be found that cities with wide streets are as congested, in proportion to building and population densities, as cities with comparatively narrow streets; and, moreover, that widening streets does not in itself, except for very short periods, lessen congestion. It is apparent that doubling the width of a street, or double-decking it for the same width, will not lessen congestion if the traffic is doubled soon after the increased capacity is provided. And so long as the street system (apart from widths) is badly planned and is combined with overbuilding and an ill-assorted arrangement of industry, business and residence, no widening of streets can do more than temporarily relieve congestion. Indeed, it may increase it, if the widening is made the excuse to increase the over-building, and further extend the disorderly arrangement of functions."

### The Engineer Defined Anew

Various phrases and paragraphs have been developed by this group and that, in the attempt to define the engineer. The latest of these attempts was developed just recently by a small conference in which the A. S. C. E., A. S. M. E., A. I. M. E. and S. A. E. were represented.

The purpose of this particular conference was to prepare a statement of not over 50 words which could be submitted to the Bureau of Census as a guide for the census enumerator to decide upon the proper designation of those who might claim to be engineers.

The following statement was agreed upon: "The engineer is a man or woman of professional training or experience who applies engineering principles to research, design, construction, operation or production, or who imparts technical instruction in these fields. The professional engineer must be carefully differentiated from the machine or engine operative."

### Cornell to Teach Hotel Engineering

Cornell University offers as part of its summer curriculum a course in hotel engineering, extending from July 8 to July 27. It will deal with typical mechanical and electrical equipment of hotels—plumbing, fire protection, communication systems, kitchen appliances, laundry machinery, vacuum cleaners, lighting, elevators, mechanical refrigeration, low pressure boilers, heating and ventilating systems. The course is intended for owners, managers and front office men.

## Recent Legal Decisions

### REQUIRED DETAILS OF PAVING IMPROVEMENT ORDINANCE AND ESTIMATE FOR ASSESSMENT

The Illinois Supreme Court holds, *City of Ottawa v. Hulse*, 332 Ill. 286, 163 N. E. 685, that a paving improvement ordinance need not state in detail the grade of every intersecting street to be improved. It is sufficient if it fixes the grade of the improvement in such a manner that the elevation of the curb and pavement reasonably appears from a consideration of the ordinance as a whole. The Illinois Local Improvement Act only requires that the estimate forming the basis for the assessment of a paving improvement be itemized to the satisfaction of the board of local improvements, and it is sufficient, so far as property owners are concerned, if the estimate is so specific as to give a general idea of the cost of each of the substantial component elements of the improvement.

### CONTRACTOR'S CLAIM FOR EXTRA WORK ON ROAD CONSTRUCTION CONTRACT

The Indiana Supreme Court holds, *Pulse v. Board of Courts of County of Decatur*, 163 N. E. 609, that in proceeding to improve highways by taxation, the board of commissioners acts as the agent of the taxpayers within the taxing district. The contract for the construction of a highway under the "Three Mile Road Law" authorized the commissioners to make changes and additions at specified unit prices. The commissioners required the contractor to do extra work. It was held that the fact that the fund derived from the sale of bonds to pay the original contract price had been exhausted before the contractors' claim for the balance due on the original contract and for the extra work was filed did not deprive the contractors of their right to a hearing in the circuit court on their appeal from the order of the commissioners disallowing their claim.

### COST OF EXTRA WORK IN SLOPING CUTS WHEN REGRADE STREET

In an action to cancel special tax bills for regading a street, it appeared that the lot owners were parties to an agreement with the mayor, common council and board of public works, consenting to the inclusion in the tax bills of the cost of extra work in removing earth and rocks to slope off the sides of cuts to prevent such earth and rocks from falling into the street. The grading contract provided for a payment of 96½ cents per square yard. The actual cost of the extra work was kept note of by the city officials, and was determined to be \$2 per square yard. It was held, *Austin v. Dickey*, Missouri Supreme Court, 9 S. W. (2d) 593, that the agreement did not contemplate the payment of only 96½ cents per square yard for this extra work. If it had been the intention to do so, it would have been so stated in the agreement.

Where the charter provision as to letting all such public work to the lowest and best bidder was not followed in providing for this extra work, but the lot owners consented to it without a compliance with the provision, and to its inclusion in the tax bills, the contractor relying on such consent, it was held the lot owners could not complain in the suit to cancel the bills.

### REVOCATION OF DEDICATION OF LAND NOT USED FOR PARK

Where property has been dedicated by the owner to a public use, but has not been used by the public, and neither the public nor any third person has acquired any rights because of the dedication, the dedication may be revoked. Where a city owned property and passed an ordinance to the effect that it would be used as a park and should not be leased or sold, but the property was never used as a park, and nothing was done to give effect to the ordinance, it was held, *Lester v. Walker*, Arkansas Supreme Court, 9 S. W. (2d) 323, that a subsequent ordinance authorizing the sale of the property to the county necessarily repealed the first ordinance and revoked the intended dedication.

### COST OF PAVING OF BOULEVARDS

The Michigan Supreme Court, *Miller v. City of Detroit*, 244 Mich. 38, 221 N. W. 292, holds that where a city charter provided for a commissioner of parks and boulevards, and granted such officer power to control and manage boulevards and pave them, the expense to be borne by the city at large, boulevards may be paved and a petition to that end may be signed by a lot owner without committing him to assessment liability. The action of the city in declaring boulevards taken into the city as boulevards should be streets and then directing paving thereof and levying paving assessments was held to be void.

### CONSTRUCTION OF AGREEMENT AS TO SALE OF LAND TO CITY COVERING DAMAGES

The Oklahoma Supreme Court holds, *Poston v. City of McAlester*, 268 Pac. 1110, that, in an agreement between a landowner and a city, in which the former agrees to sell the latter 30 acres of land on which the city has impounded water for public use and the landowner executes and delivers a deed to the city for such purpose, the settlement covers all damages to which the landowner would have been entitled in a regular condemnation proceeding. The owner is presumed to have contemplated and arranged for such damages in fixing the consideration for the deed.

### JURISDICTION OF ACTION FOR MATERIAL FURNISHED CONTRACTOR FOR FEDERAL GOVERNMENT WORK

In an action in a state court against contractors and their sureties for material furnished the contractors in making improvements on a United States reservation, it was held, *Hot Springs Concrete Co. v. Rosamond*, 10 S. W. (2d) 12, that, since no action against the sureties on the bond could be brought in any court other than the United States District Court, under 40 U. S. Code Annotated §270, the state court had no jurisdiction as to the surety companies in the action, and it was the duty of the court to dismiss it as to the sureties, under *Crawford & Moses Digest*, §§1189, 1239; but where the complaint stated a complete cause of action against the contractors, without reference to the bond or the sureties, it should not have been dismissed as to them, the contractors being liable in any event if they purchased material and did not pay for it.

#### **CITY'S LOTS HELD EXEMPT FROM TAXATION UNDER OREGON STATUTE**

Where a city purchased lands for a municipal park, and a portion thereof not used for park purposes was plotted into lots and offered for sale, the question was whether it was exempt from taxation under the Oregon statute exempting all public or corporate property used or intended for corporate purposes. The Oregon Supreme Court holds, *City of Portland v. Welch*, 269 Pac. 868, that the use of both the words "public" and "corporate" showed that the statute intended to include all property of every nature belonging to the city. The use of the words "used or intended for corporate purposes" would not take the plotted lots out of the exemption, because the property was held by the city for sale and when so sold the proceeds would be applied to the public revenues, and, being so held for such purpose, it was being "used or intended for corporate purposes." The court added: "If property belonging to the state or to an agency of the state should be made the subject of taxation, the burden of the taxpayer would not thereby be diminished, but would be increased by such additional expense as would be incidental to its collection;" and the court will not construe a statute as providing for taxation of property belonging to the public, in the absence of an express declaration so providing.

#### **ORNAMENTAL LIGHTING SYSTEM HELD PROPER SUBJECT MATTER OF LOCAL ASSESSMENT**

Holding that an ornamental lighting system for city streets, by adding character to the locality, eliminating existing wooden posts and overhead wires, and employing a lamp of greater brilliance, confers a benefit upon the adjacent district which makes it the proper subject-matter of local assessment, the Oregon Supreme Court says, *Fisher v. City of Astoria*: "Before the expense of installing an improvement can be assessed against the property in a district, it is essential that the improvement should confer a substantial benefit upon the property within the district. It may incidentally benefit the entire city; that wholesome effect will not destroy its use as the foundation for a local assessment provided it brings to the proposed district a benefit substantially more intense than it yields to the rest of the municipality, or in the event its beneficial effect upon the local property is peculiar to that district."

#### **WAIVER AS BETWEEN CONTRACTORS OF PROVISION REQUIRING WRITTEN AUTHORITY FOR EXTRA WORK**

In an action by a subcontractor against a contractor for government work in which a sum for extra work was claimed, the defendants contended that the items for extra work should not have been submitted to the jury because the work was not "authorized in writing by the contractor to the subcontractor," as required by the contract. The plaintiff admitted that there was no written order given for the work by the contractor to the subcontractor, but said that there was a parol agreement between the parties that the work should be done and the written authorization was thereby waived. The action, by the United States for the use of the subcontractor, was brought in the federal district court for New Jersey, and the Circuit Court of Appeals, Third Circuit, *Lord Const. Co. v. United States*, 28 Fed. (2d) 340, said: "A written contract may be waived by a parol agreement, but the evidence

establishing it must (1) be clear and of a satisfactory character; (2) clearly show a distinct agreement by the parties that the work shall be deemed extra work; (3) show a definite agreement by the owner or contractor to pay extra for the extra work. This was a New Jersey contract, and is to be controlled by the law of New Jersey. If, however, it is contended that it is not a New Jersey contract, then it is controlled by federal decisions, and they are to the same effect. \* \* \* If there was a parol agreement, the items for extra work should not have been withdrawn from the jury. Whether or not there was such agreement authorizing these extras and waiving written authorization 'by the contractor to the subcontractor' was a question for the determination of the jury. The verdict shows the jury found there was such an agreement. There was testimony sufficient to support its finding. The verdict therefore settles the fact." Judgment for the plaintiff was affirmed.

A written contract was entered into between the contractor for the construction of a portion of a public highway between two points and a subcontractor, the latter to be paid upon the basis of unit prices for the work to be done. The state highway engineer changed the route of the highway between certain points, as he was authorized to do by the specifications to the main contract. The subcontractor did work under the changed plans, and payments were made to him on the basis of the written contract, which he accepted without demur, and also payment for his loss of time while the alterations in the plans were made. The subcontractor sued the principal contractor for breach of the original contract, and sought to recover the profits he could have made had the line of road not been changed. The Wyoming Supreme Court holds, *Snowball v. Maney Bros. & Co.*, 270 Pac. 167, that he could not recover, his course of conduct after the change was resolved upon showing that he acquiesced in the change.

The court said as to the provision in the main contract authorizing changes in the plans by the state highway engineer, but requiring any alterations to be made in writing (which apparently was not done in this case) that "the purpose of such provision seems to be to protect the owner of property against any unwarranted claims of the contractor. Such a provision may be waived or modified by oral contract. It has always been appealed to by the owner, not the contractor, so far as we are able to learn. But, of course, if the owner of property, who causes work to be done, may waive it, the contractor, or subcontractor, may do likewise."

#### **CHARTER AUTHORIZATION OF SPECIAL ASSESSMENT FOR WHITE WAY SYSTEM**

Article 1, Subd. D of the charter of the city of Muskogee authorizes the city to provide by special assessment for payment of all benefits for special lighting districts, and for sprinkling, cleaning and repairing streets. The Oklahoma Supreme Court holds, *Bragdon v. City of Muskogee*, 271 Pac. 1006, that this charter provision is authorized by section 7, article 10 of the state constitution, and by virtue thereof the city has the power to levy taxes for the local improvement designated as a white way system. The authorization of the charter carries with it the authority to prescribe the method and procedure used in organizing and making such improvement.

#### **VALIDITY OF ORDINANCE PROHIBITING OBSTRUCTIONS IN STREETS AND PARKINGS**

Oklahoma Comp. Stat. 1921, section 4564, confers wide discretionary powers upon the governing body in cities and towns as to regulation and control of streets and parkings within the city or town, subject only to being exercised in such a manner as not to be arbitrary or discriminatory. The Oklahoma Supreme Court holds, *Palace Garage v. Oklahoma City*, 268 Pac. 240, that the passage of an ordinance prohibiting the establishing of certain obstructions in the streets and parkings of the city, and likewise prohibiting the continuation of those already established is a valid exercise of the city's police power. The permission of the city, prior to the passage of such an ordinance, of obstructions on the streets and parkings of the city, is held to confer no vested rights therein.

#### **SUFFICIENCY OF NOTICE OF TIME LIMIT IN COMPETITIVE BIDDING**

In an action by a taxpayer to enjoin a city from entering into a contract for the construction of a bridge in the city, it was contended that the bids were not competitive because the plans and specifications did not state the number of working days required, within which the work was to be completed. The plans and specifications did not provide a time limit for completion of the work, but did contain a provision making the advertisement or notice to bidders a part of the contract with the successful bidder. The advertisement or notice to bidders fixed the time limit for the completion of the work at 200 working days. The Oklahoma Supreme Court holds, *Deutsch v. Oklahoma City*, 270 Pac. 851, that the time limit placed therein was sufficient to constitute competitive bidding.

#### **STATUTORY AUTHORITY FOR INCLUDING ENGINEERS' AND ATTORNEYS' FEES IN PAVING IMPROVEMENT ASSESSMENT**

The New Mexico Supreme Court holds, *Massengill v. City of Clovis*, 270 Pac. 886, that, under the New Mexico statutes relative to paving improvements, engineers' and attorneys' fees are properly chargeable as a part of the costs of a paving improvement, and, as such, are properly included in a local assessment against abutting owners, and that no question of sound public policy prevents such payment upon a basis of a percentage of the cost of a pavement program.

#### **WHAT CONSTITUTES A "FIRST PAVING" IN PENNSYLVANIA**

The Pennsylvania courts hold that a first paving which exempts abutting property owners from liability for subsequent improvement is one put down originally as a permanent improvement, or one that has been adopted as such by municipal authorities. Two elements are necessary to evidence the fact of adoption, the character of the construction and the municipality's intention to convert the road into a permanent improved street. While the controlling consideration is affirmative municipal intention, due consideration will be given to the character of the work done. In Philadelphia the case of *Eastman Asphalt Co. v. Muller*, 143 Atl. 20, the facts relied on to show a "first paving," as the term is understood, were, a modern stone macadam pavement, the repair of the street by the city, the installation of sewer, gas and water pipes, the assessment of the property by the city at full city rates, the exaction of a larger fee for

breaking into this street than an ordinary street, that other portions on the same street had been paved throughout at the city's expense, and that the work was done under the direction of the city's board of surveyors. It was held that all these facts, combined or separately, were not enough to show that the city adopted the work as an original improvement.

#### **CONSTRUCTION OF CONTRACT OF EMPLOYMENT OF ROAD CONTRACTOR'S SUPERINTENDENT**

A contractor for state highway construction work sublet part of it and employed a superintendent for the work he reserved for himself. After the work was done, the superintendent, in an action against the contractor, claimed that in addition to the weekly compensation which had been paid him, he was to receive \$1,000 when the work of laying the concrete was done, if it was properly done. The defendant denied that he had made such a contract, but admitted agreeing that, if the superintendent performed his work satisfactorily, he would pay him a bonus of \$1,000 on the completion of the contract. The jury found for the plaintiff, less certain admitted reductions. The defendant appealed. The principal ground for appeal was that the trial court erroneously refused to permit the defendant to prove that the contract between himself and the state highway commission had not been completed according to its terms. The New Jersey Court of Errors and Appeals held, *Burkett v. Ellis*, 143 Atl. 347, that the testimony was properly excluded. "All that the plaintiff was required to do under his contract was to see to it that the work done by the defendant's employes was properly done. He was under no further obligation; that is, it was not within the scope of his employment to see that the defendant properly performed his contract with the state highway commission."

In accordance with the law of New Jersey, the appellate court declined to review the weight of the evidence in a civil cause.

#### **STATUTORY HIGHWAY CONSTRUCTION CONTRACTOR'S BOND DOES NOT COVER DAMAGE TO LAND AND TIMBER BY FIRE NEGLIGENTLY SET**

Action was brought on a bond executed by a contractor constructing a state highway, guaranteeing performance of the work and payment for material and labor in and about the construction of the road. It was held, *Roper Lumber Co. v. Lawson*, 195 N. C. 840, 143 S. E. 847, that the bond did not cover damage to land and timber thereon by a fire negligently set out by the contractor or his employees. The bond was construed along with the proposals, plans, specifications and contract. It was executed for a dual purpose, for the protection of the state highway commission and for the payment of labor and material to those furnishing same. North Carolina Public Laws 1925, c. 260, § 1, authorizing claims against the contractor and his bond by any laborer, materialman "or other person" did not include any person having a claim against the contractor, the ejusdem generis rule applying and limiting the phrase to mean persons of the same kind or class as those specifically mentioned. The court said that "if actions for a tort like the present or personal injuries are contemplated, this should be fully and clearly provided for by the surety bond in reasonably clear language."

**NECESSITY FOR COMPLIANCE WITH CONTRACT PROVISION AS TO WRITTEN ORDER FOR EXTRA WORK**

The New Jersey Court of Errors and Appeals holds, *Mansfield v. Cape May County*, 143 Atl. 379, that where the specifications for repairing and rebuilding a bridge provided: "The contractor must at all times comply with the requirements of the specifications, and shall not on any pretense save that of a written order from the contracting parties or the engineer, deviate from the intent of the specifications," the contractor could not recover for extra work performed without the required written authority. Following *Landstra v. Bunn*, 81 N. J. Law 860, the court holds that: "Where persons contract with each other regarding what shall be their course of conduct with each other, regarding a certain subject-matter, and declare that there shall be no change in their agreement, which shall vest an additional liability in favor of or against each other, without authority to do so in writing, the mere performance of such extra service without such written authority will not give rise to an implied waiver of the provisions of the contract in that respect; so without proof of alterations in the contract, by the parties, or express proof of waiver of its terms, the plaintiff in order to recover was bound to produce the order of the engineer stipulated for in the agreement."

**MUNICIPALITY NOT LIABLE IN DAMAGES TO ONE OWNER FOR OVERFLOW OF SURFACE WATER DAMAGING SEVERAL OWNERS**

An owner sued the municipality for injuries to his property by surface water flowing down the street and over his land because the borough had installed a drain insufficient in capacity to take care of the surface water in time of storm, contending that in making such installation the borough was guilty of active wrongdoing and so responsible for all damages resulting therefrom to property owners. On proof that other property owners facing the street were damaged in the same way, a nonsuit was directed on the theory that the neglect of a municipal corporation in the performance of a public duty imposed upon it by law, resulting in injury to property owners in the municipality, did not constitute the basis of a civil action by an individual who has suffered particular damage by reason of such neglect. This judgment the New Jersey Court of Errors and Appeals affirmed, *Arun v. Borough of Northvale*, 143 Atl. 437, holding that the neglect of the municipality in such circumstances is a public wrong to be remedied by indictment and not by civil action for the damage caused to a particular individual.

**PURCHASE OF FIRE APPARATUS BY MUNICIPALITY**

In an action involving the right of a municipality to award the contract for the supply of a fire truck and miscellaneous fire equipment, *Simmons v. Mayor & Council of Wenonah*, 143 Atl. 73, the New Jersey Supreme Court, following *Hahn Motor Truck Corp. v. Atlantic City*, 140 Atl. 675, says that "it is impossible for a municipality to draft specifications for fire apparatus which would apply to all fire apparatus, for the reason that each manufacturer makes his apparatus as a rule under patents or designs different from those of other manufacturers. It is these differences which support the claims of the superiority of apparatus made by each manufacturer over that manufactured by his competitors. A municipality has

discretion, within proper limits, as to the apparatus which it will purchase." In the *Hahn Motor Truck Corp.* case it was held that the New Jersey statute requiring competitive bidding does not apply to the purchase of fire apparatus by a municipality.

**DISTINCTION BETWEEN REPAIR OF ROAD AND NEW CONSTRUCTION AUTHORIZING ASSESSMENT**

In 1914 the state of Ohio improved a section of a highway by original construction, with water-bound macadam, and thereafter maintained it by applying treatments of crushed limestone and tar. In 1923 and 1924 it was rebuilt by the highway director; two new culverts were constructed; the pavement was widened, and a wearing course of bituminous macadam was placed on the top of the original material. The Ohio Court of Appeals holds, 29 Ohio App., 1, 163 N. E. 34, that the improvement was not "new construction," but a repair of the road, and the assessment of the cost of it against neighboring property was not authorized. The type of the road was not changed so as to authorize assessment under Ohio Gen. Code §1224. To authorize such assessment, not only must the type of road be changed in repairing a road, but the director of highways must also use, as the principal material in such repairs, a material different from that used in the original construction.

**DISCRETION TO PAVE PART OF SPACE BETWEEN SIDEWALKS**

Under Kentucky St., § 3096, providing for the improvement of the streets in cities at the exclusive cost of the owners of abutting real estate, and § 3098, giving city authorities full power to determine what streets or parts thereof shall be improved and the extent and character of the improvement, the fact that a city acquired from a street railway its 20 foot right of way in the middle of the street did not make it liable for a proportion of the cost of hard-surfacing the driveway on either side of the strip. The city was not required to improve the whole space between the sidewalks. It could exercise its discretion as to the width and improve what was necessary. By not ordering the centre strip paved the abutting owner was simply saved that much expense, and has no cause to complain of the letting of a contract for the improvement.

**COST OF ENGINEERING AND INSPECTION SERVICES HELD PROPERLY INCLUDED IN ASSESSMENT FOR STREET IMPROVEMENT**

The Missouri Supreme Court holds, *Pflueger v. Kinsey*, 6 S. W. (2d) 604, that under the St. Louis City Charter, art. 22, § 2, providing for engineering service before bids are advertised, and inspection service being one of trust and an integral part of the cost of an improvement, the levy of an assessment against realty for the engineering and inspection services in making a street improvement, rendered by engineers and inspectors who were regular city officials, whose salaries were paid out of the general revenue of the city was proper. It was held unnecessary to submit these items of work to competitive bidding, since the charter did not provide that the amount levied should be limited to the amount of the contract let. A levy of 6 per cent for engineering and inspection was not unauthorized because it was based on an estimate of the probable cost of these services made in advance of their performance.

## Engineering Societies

**July 10-12—AMERICAN SOCIETY OF CIVIL ENGINEERS.** Annual Meeting at Milwaukee, Wisc. George T. Seabury, Secretary, 33 W. 39th St., New York.

**Aug. 25-27—AMERICAN ASSOCIATION OF ENGINEERS.** Annual Convention at Mexico City. M. E. McIver, Secretary, Chicago, Ill.

**Sept. 17-20—NEW ENGLAND WATER WORKS ASSOCIATION.** Annual Convention at Portland, Me. F. J. Gifford, Secretary, 715 Tremont Temple, Boston, Mass.

**Sept. 30-Oct. 4—AMERICAN PUBLIC HEALTH ASSOCIATION.** Annual Convention at Minneapolis, Minn. Homer M. Calver, Secretary, 370 Seventh Ave., N. Y.

**Oct. 14-16—SOUTHWEST WATER WORKS ASSOCIATION.** Annual Convention at Tulsa, Okla. L. A. Quigley, Secretary, Fort Worth, Tex.

**Oct. 14-16—INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS.** Annual Convention at Jacksonville, Fla. A. M. Anderson, Secretary, 100 North LaSalle St., Chicago, Ill.

**Oct. 14-19—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS.** Annual Convention at Philadelphia, Pa. C. V. S. Sammelman, Secretary, St. Louis, Mo.

**Oct. 28-Nov. 1—ASPHALT PAVING CONFERENCE.** Eighth Annual Meeting at West Baden, Ind. J. E. Pennybacker, Secretary, 441 Lexington Ave., N. Y.

**Nov. 12-14—NATIONAL MUNICIPAL LEAGUE.** Annual Convention at Chicago, Ill. Secretary, Russell Forbes, 261 Broadway, N. Y.

**Nov. 20-23—INTERNATIONAL CITY MANAGERS' ASSOCIATION.** Annual Convention at Fort Worth, Tex. Executive Secretary, John G. Stutz, Lawrence, Kans.

### Asphalt Paving Conference

The Eighth Annual Asphalt Paving Conference, which will be held October 28 to November 1, at West Baden, Ind., under the auspices of The Asphalt Association, New York, will be of importance on account of the fact that the improvement of farm-to-market roads will be the keynote of the meeting. Airport paving will also be given serious attention, along with city street construction and trunk-line highway improvement. Greater attention will be given to discussions of the latest and most economical methods evolved for the construction with asphalt of low-cost surfaces on the secondary and tributary highways. Salvaging of existing gravel and macadam roads and their utilization as bases for low cost asphalt surfaces will receive important consideration as one of the measures figuring heavily in any farm-to-market road paving program.

The Association of Asphalt Paving Technologists will hold its annual meeting in connection with the conference. The sessions of this organization, alternating with those under the auspices of The Asphalt Association, will provide discussions pertaining to the technical side of asphalt construction and affording research information of value to the technical men in attendance. W. J. Emmons of Ann Arbor, Mich., and C.

A. Mullen of Montreal, Canada, this year, are president and secretary, respectively, of the Association of Asphalt Paving Technologists.

The matter of paving the secondary and tributary highways, or farm-to-market roads, with low cost bituminous surfaces, is assuming great importance in the eyes of highway engineers and officials, farm, business and motoring organizations and law-makers in Congress and the several state legislatures, and promises to become an important factor in highway improvement during the next few years. Farm organization representatives, as well as engineering and technical men will participate in the sessions of the conference.

Investigation discloses, according to farm organization officials, that only three per cent of American farms are located along highways now paved with the hard surfaced types of construction and seventy-four per cent of American farms are still located on unimproved dirt roads. The program being evolved "to get the farmer out of the mud," forms a feature of the general project for farm relief. Nearly 5,000,000 American farmers are still living on dirt roads that are muddy in wet weather, dusty in hot weather and rough in cold weather, and have little or no means of access to the main paved roads during many months of the year.

Meanwhile, notwithstanding the expenditure of \$2,000,000,000 annually, on roads in this country, the main highways, particularly near the big cities, and especially on holidays and during week-ends, are becoming more and more congested. It is because of their desire to escape this congestion and to do their pleasure driving in the "back country" districts, that motorists in all parts of the country are beginning to give their support to the farm-to-market road paving program.

There are approximately 3,000,000 miles of highways in the United States, of which 287,000 miles are state roads and 2,700,000 are local roads. A total of 1,800,000 miles of road are still ungraded; 630,000 are merely graded and drained earth roads, and 300,000 miles are surfaced only with gravel. It is the group of low type improved or graded roads, represented by the water-bound macadam, gravel, sand-clay and graded and drained earth that furnishes the most serious problem for highway engineers and officials. Of the 61,000 miles of waterbound macadam, approximately 30,000 miles are yet to be surface-treated, along with 292,000 miles of gravel and 694,000 miles of earth and sand-clay roads.

Elaborate entertainment features will be provided during the conference, the attendance at which is expected to surpass that of the 800 registered at the New Orleans meeting last year.

### American Road Builders' Association

On June fourth, sixth and seventh the American Road Builders' Association held meetings in Cleveland, Chicago and Milwaukee respectively, for groups of the Highway Industries As-

## AYER & LORD TIE Co.

Incorporated 1893

CHICAGO

RAILROAD CROSS TIES  
BRIDGE TIMBERS  
CAR STOCKS  
LUMBER  
PILING  
POLES  
POSTS

TREATING PLANTS

Carbondale, Ill. Louisville, Ky.  
Grenada, Miss. Montgomery, Ala.  
North Little Rock, Ark.

"FROM THE TREE  
TO THE JOB"

## STEEL SHEET PILING

New and Used

Rails, Equipment, Oil Engines, Etc.

**ZELNICKER IN ST. LOUIS**

Our 28-page Bulletins keep you posted on what is available.

Sent Free on Request

## FLOCKHART FOUNDRY CO.

82 Polk St., Newark, N. J.

Specializing in the design and manufacture of highway castings that last.

We believe that our experience in designing castings is sufficient to warrant the offer of a free designing service to engineers.

We guarantee our castings not to fail in service.

Write for our data sheets.

## Tarpaulins

in all sizes

## Tents

of all kinds for housing gangs, teams and equipment.

Write for low prices.

**H. WENZEL TENT  
& DUCK COMPANY**

1020 Paul St. St. Louis

## JUST PUBLISHED!

# Sanitary Engineering

By W. A. Hardenbergh

Associate Editor PUBLIC WORKS

Complete in three handy volumes:

WATER SUPPLY	177 pages	79 illustrations
SEWERAGE	158 pages	70 illustrations
WATER PURIFICATION	178 pages	36 illustrations
SEWAGE TREATMENT		
MUNICIPAL REFUSE	513 pages	185 illustrations

These books cover adequately but briefly the essential data regarding the above subjects. Especially are they adapted to the Public Health Engineering Field.

Attractively bound in blue, semi-flexible covers.

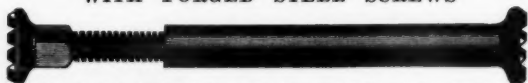
Price \$5.00, postpaid—Volumes also sold separately

Public Works Book Dept., 310 East 45th St., New York, N. Y.

## KALAMAZOO TRENCHING BRACES

WITH FORGED STEEL SCREWS

Complete  
Stock



Prompt  
Shipment

WRENCH FREE WITH EVERY TWO DOZEN

Not excelled for narrow and medium width trenches. Mud guards desirable where concrete or mud hardens on braces. The only brace that is free from projections that hinder workmen in the ditch. Kalamazoo timber brace fittings are suitable for wider trenches.

KALAMAZOO FOUNDRY & MACHINE CO. 570 East Main St. Kalamazoo, Mich.



## JOINTITE

### A SEWER PIPE JOINT COMPOUND

No caulking is necessary with JOINTITE. Alternate joints may be poured on the bank. No skilled help required. Excludes ground water, thus paying for itself.

### 7 CATALOGS

on Airlock Apparatus for Sewers and Sewage Disposal

Catalog No. 22—Flush Tank Siphons, Water Regulators.  
Catalog No. 25—Automatic Siphons for Domestic Septic Tanks.  
Catalog No. 21—Pneumatic Sewage Ejectors.

Catalog No. 29—Sewage Pipe Joint Compound.  
Catalog Nos. 30 and 24—Automatic Siphons for Large Municipal Disposal Plants, etc.  
Catalog No. 31—Imhoff Tanks.

Catalogs mailed on request

## PACIFIC FLUSH-TANK CO.

4241 Ravenswood Avenue, Chicago

9 Park Place, New York

sociation (Manufacturers' Division of the American Road Builders' Association). The meetings were in the form of luncheons in Chicago and Milwaukee and a dinner in Cleveland. On June 19, a luncheon was held in New York.

At each meeting a complete and comprehensive outline of the past and present activities of the Association was presented by Charles M. Upham, Secretary-Director of the Association. This outline included a description of the present organization, the seven divisions by which it functions and the method of obtaining educational information through committees made up of nationally known engineers and highway officials.

Much stress was placed on the necessity of continued and increasing activity along the lines of good roads publicity and information in order that the public may be rightly informed as to the real value of highways and to combat evils and violations of correct practice which might cause a diminution of highway activity.

A few of the evils were cited, such as misuse of the gas tax and the organized effort by certain forces for reduction of this highway toll. It was pointed out that these adverse factors should be combatted and that this can best be accomplished through the efforts of a nationally known association such as this.

Other factors were mentioned constructively such as necessity for widening programs, the possibilities of highway bonding and the improvement of highway management in counties and cities. The statement was made that the Association was giving close and scientific study to all these subjects through its engineering force and committees, and is well equipped to benefit materially the entire highway industry.

The functioning of the Pan-American Division was explained and the description and purpose of the International Group were presented in detail.

The question of regional road shows, of annual shows, location, and the approaching convention and exposition at Atlantic City was discussed.

The presentation of activities was brought to a close by an account of budget expenditures for the current year, including the division of funds for the various Association activities.

Following Mr. Upham's presentation of information, a general discussion of all subjects and policies was invited.

The conclusions secured through these discussions and which represent in some instances the opinions of individual manufacturers and in others the result of a vote are as follows:

A unanimous opinion that the educational and scientific work of the association shall continue.

A unanimous opinion that the funds expended by the Association along educational and scientific lines are not excessive.

The greater percentage of manufacturers are in favor of an annual exposition held in different parts of the country.

The greater percentage of manufacturers are not in favor of regional shows.

### American Municipal Association

The date of the sixth annual meeting of the American Municipal Association has been set for November 14, 15, and 16, at Chicago, Illinois. The meeting place in Chicago has not been designated. The National Municipal League, the Governmental Research Association, and the Civic Secretaries will hold their convention in Chicago, November 12, 13, and 14.

### Second Pan-American Congress

The second Pan-American Congress will be held at Rio Janeiro, Brazil, August 16-31.

### New England Water Works Assn.

The committee appointed to nominate officers to the Association for 1929-1930 has reported the following nominations: For President, Robert Spurr Weston, Boston, Mass.; for Vice-president, George C. Brehm, Waltham, Mass.; for Treasurer, Albert L. Sawyer, Haverhill, Mass.; for Directors, E. Sherman Chase, Boston, Mass., and R. A. Cairns, Waterbury, Conn.

### Mayors' Conference of N. Y. State

Mayor Frederick G. McLaughlin of White Plains was re-elected president of the New York State Mayors' Conference held at Binghamton, June 18-19, and Utica was chosen as the 1930 convention city. Other officers elected were: Vice-president, Mayor Joseph C. Wilson, of Rochester; treasurer, Mayor John Boyd Thacher, of Albany; members of State Municipal Bureau Council, Mayor Charles G. Hanna, of Syracuse; Mayor Walter J. Lohr, of Lackawanna, and Mayor Benjamin Radeau, of New Rochelle.

## Personals

E. S. Anderson, formerly city engineer of Zeeland, Mich., has been appointed city manager of Mt. Pleasant, Mich.

A. L. Kroeger has been appointed engineer in charge of construction for the Durango, Colo., water system.

George W. McCordic, Ralph A. Stadler and George A. Larson have organized the engineering firm of McCordic, Stadler and Larson, Detroit, Mich. The new firm will specialize in sewerage, sewage disposal, drainage, water supply, paving and other municipal work.



## Thousands of improvements in central office equipment in 5 years

*An Advertisement of the  
American Telephone and Telegraph Company*



IN THE last five years there have been hundreds of improvements of major importance in telephone central office equipment in the Bell System, and lesser improvements by the thousands. Improvements have been made in switchboard cable, in relays, in cords, in condensers, in selectors, and in the development of new and better materials for all kinds of equipment used in the central offices.

These improvements have not only helped to meet the steadily increasing complexity of telephone

requirements. They also make possible the high-speed service which is eliminating delay from the personal contacts of people anywhere in the United States, whether they be separated by three floors of a building or three thousand miles of country.

There is no standing still in the Bell System. Better and better telephone service at the lowest cost is the goal. Present improvements constantly going into effect are but the foundation for the greater service of the future.

The Consulting Engineers' Division, Cleveland Engineering Society, has elected J. W. Ellms, consulting sanitary engineer, chairman, succeeding Kenneth H. Osborn, who has served in this capacity for the past two years.

A. W. Newby, former vice-president, has been elected president and general manager of The Huber Manufacturing Company, Marion, Ohio, to succeed S. E. Barlow, resigned. Mr. Barlow was elected chairman of the board.

Wayne E. Timmerman, village engineer of Massena, N. Y., has been appointed city manager of Saranac Lake, New York.

E. B. Johnson, for the past three years health officer of Framingham, Mass., and before that assistant sanitary engineer of the Alabama State Board of Health, has been appointed assistant sanitary engineer of the Louisiana State Board of Health, in charge of mosquito control, with headquarters at Monroe.

D. A. Tolbert, of Denver, Colo., has been appointed town engineer of Asher, Okla.

William V. Montin, formerly city manager of Big Spring, Texas, has been appointed city manager of Guthrie, Okla.

Paul Morton, city manager of Alexandria, Va., for the past four years, has resigned to become city manager of Petersburg, Va.

S. Bent Russell has opened an office at 4950 Washington Boulevard, St. Louis, Mo., for the practice of engineering. He will cover municipal engineering, waterworks, industrial buildings, and machine design.

Thomas H. Andrews has been appointed Chief Engineer of the Federal Bridge Company of 46 Cedar Street, New York City. Mr. Andrews was formerly with the Mexican Federal Highway Commission and the State Highway Commissions of North Carolina and Florida.

H. M. Renner, city manager of Mangum, Okla., for the past three years, has been appointed city manager of Woodward, Okla. H. T. Lawrence, chief engineer of the Edward Gantt Engrg. Co., Oklahoma City, has been appointed city manager of Mangum, succeeding Mr. Renner.

The officers of the La France-Republic Corporation, manufacturers of American-La France and Republic trucks and Linn tractors, include Joseph A. Bower, chairman of the board; Wallace J. Childs, chairman of the executive committee; Chas. B. Rose, president; George R. Hanks and Frank L. Pierce, vice-presidents.

Paradon Mfg. Co., Arlington, N. J., announces the appointment of L. E. Layne, of 30 North Michigan Ave., Chicago, Illinois, as a direct factory representative. Mr. Layne will have charge of the sales and servicing of Paradon Chlorinators in the States of Illinois, Indiana and Southern Wisconsin.

## Book Reviews

*Manual of Second and Third Order Triangulation and Traverse.*—This publication contains a description of the specifications and criteria for second and third order triangulation, traverse and base measurement, with detailed instructions for field and office operations and specimens of field records and office computations.

So far as it is known, this is the first detailed description of field and office operations necessary for second-order horizontal control that has been published in the United States. While written particularly to meet the needs of the Coast and Geodetic Survey, the treatment of the subject is sufficiently broad to make the manual of great value to any engineer who may be called upon to execute second or third order horizontal control. The section on instrumental adjustments and errors and the discussions of the sources of error on triangulation and traverse are written in considerable detail.

This publication completes the series of horizontal control manuals of the Coast and Geodetic Survey. There have been previously published within the past four years the Manual of First Order Triangulation, Special Publication No. 120, and the Manual of First Order Traverse, Special Publication No. 137, while such fourth order control as is done by this bureau is described in the Hydrographic Manual, Special Publication No. 143, and the Topographic Manual, Special Publication No. 144. These publications may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., upon payment in advance of the following prices: Special Publication No. 120, 40 cents; Special Publication No. 137, 30 cents; Special Publication No. 143, 45 cents; Special Publication No. 144, 30 cents.

The Manual of Second and Third Order Triangulation and Traverse contains 226 pages and 99 illustrations. It is divided into six chapters as follows: Reconnaissance; second and third or-

der triangulation; second and third order base measurement; second and third order traverse; astronomic azimuths; constants, formulas and tables.

This publication is sold only by the Superintendent of Documents, Government Printing Office, Washington, D. C. The sale price is 60 cents. Stamps are not acceptable in payment for publications.

*Governmental Purchasing.*—By Russell Forbes. 370 pages. 80 illustrations. Harper & Brothers, N. Y. \$5.

This book presents a composite of the best existing practice in governmental purchasing, and also makes recommendations for betterment. Illustrative forms for all steps are given, as is information applicable for the setting up of a new purchasing system or revising an old one.

*What Engineers Do.* By Walter D. Binger. 259 pages. Illustrated. W. W. Norton Co., \$2.75.

A discussion, from a lay point of view, by an engineer of foundations, surveying water supply and hydraulics, buildings, structures and materials. The manner of presentation is simple, clear, and interesting, and the book very well worth reading by both engineers and laymen.

## Civil Service

*Transitman.*—Applications for transitman must be on file with the Civil Service Commission at Washington, D. C., not later than July 22. The examination is to fill vacancies in the General Land Office Service. The entrance salary is \$2,000 a year. Competitors will be rated on higher mathematics, theory and practice of geodetic surveying, public land surveying, adjustment and use of instruments, and on their training and experience.

*Information.*—Full information may be obtained from the United State Civil Service Commission at Washington, D. C., or from the secretary of the United States Civil Service Board of Examiners at the Post office or custom house in any city.

### Engineers

This process, which has been in successful use for some years, has several advantages besides that of beam strength. Its use is recommended on clay and adobe, as well as open sandy subgrade.

## MONOLITE

A patented process for protecting and curing the base of concrete pavements, thus increasing beam strength and durability.

### MONOLITE COMPANY OF AMERICA

1004 HEARST BUILDING  
SAN FRANCISCO, CALIFORNIA

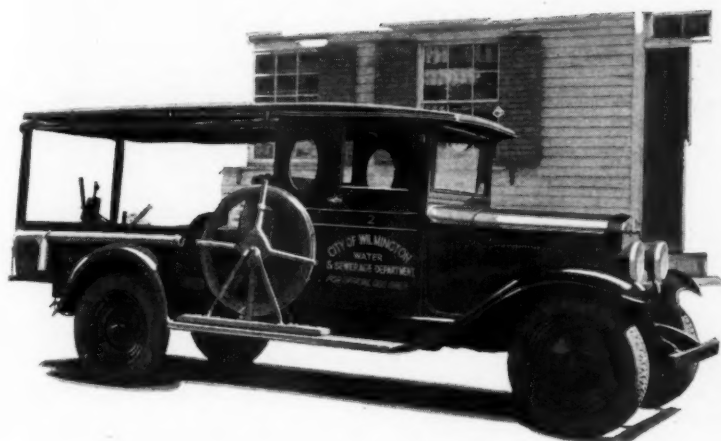
### Contractors

The advantages of this process are not alone increased strength and durability of the pavement slab, but it also effects a substantial saving in cost to the contractor in materials and labor.

# Ten Reasons for the Record-Breaking Popularity of the Six-Cylinder

## CHEVROLET TRUCKS

(for Economical Transportation)



In every section of the country, the new Chevrolet Six-Cylinder Trucks are sweeping ahead to one of the greatest records of success in the history of the commercial car industry—for these sensational new trucks meet, with unusual efficiency, the problems presented by crowded traffic conditions and modern ideas of prompt customer service.

They provide the remarkable flexibility, acceleration, speed and reserve power of the six-cylinder engine—with body types specifically designed for every business need. They afford outstanding economy of operation—and are actually available in the price range of the four!

Read, in the column at the right, the ten big reasons why truck users everywhere are turning to Chevrolet. Then get in touch with your Chevrolet dealer—and arrange for a trial load demonstration!

CHEVROLET MOTOR COMPANY, DETROIT, MICH.  
Division of General Motors Corporation

The Sedan \$595 The Light De- \$400 The 1½ Ton \$545 1½ Ton Chas- \$650  
Delivery.. livery Chassis .... sis with Cab..

All prices f. o. b. factory, Flint, Michigan

A SIX IN THE PRICE RANGE OF THE FOUR

**1 Six-Cylinder Power**—that carries full capacity loads up the steepest hills with abundant reserve power—plus the adaptability of a four-speed transmission, with power take-off opening on the 1½ ton truck.

**2 Six-Cylinder Speed and Acceleration**—that permit the servicing of wider areas, and the completion of more trips—whether in city service or suburban usage.

**3 Six-Cylinder Smoothness**—that protects the entire truck from the destructive effects of undue vibration and affords exceptional comfort to the driver even on the longest trips.

**4 Remarkable Handling Ease**—that results from a full ball bearing steering mechanism; big, non-locking four-wheel brakes; and a remarkably smooth transmission.

**5 Amazing Economy of Gasoline and Oil**—due to such advanced engineering features as hot-spot manifold, automatic acceleration pump and crankcase breathing system.

**6 Outstanding Dependability**—achieved by thoroughly tested construction in every unit—from the rugged rear axle to the large-capacity, highly efficient Harrison radiator.

**7 Extremely Economical Service**—provided by 10,000 Authorized Chevrolet Service Stations, operating under a low flat-rate system of charges.

**8 Ample Capacity**—made possible by a heavy channel steel frame, with sufficient frame length to permit the mounting of unusually large bodies without extensions.

**9 Wide Selection of Body Types**—that make Chevrolet Trucks adaptable to every line of business. And among them is one designed especially for your requirements.

**10 Amazing Low Prices**—that make Chevrolet Trucks the biggest values ever offered—combined with the lowest available financing charges for those who desire to buy on easy terms.

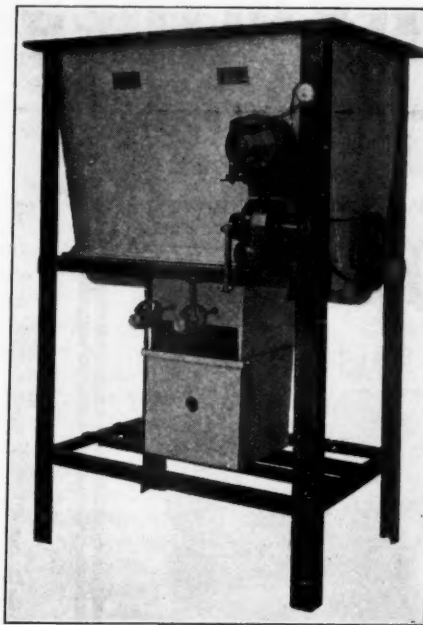
# Engineering and Construction Equipment

New Machinery, Apparatus, Materials and Methods and Recent Installations.

## Multiple Type Dry Chemical Feed Machine

E. W. Bacharach and Company, Kansas City, Mo., have recently placed on the market a multiple type of dry chemical feed machine that involves entirely new patented principles of operation. This device will accurately feed any number of dry chemical simultaneously in the same or in different amounts. The machine may also be used to feed several different amounts of the same chemical to separate points of application. The illustration shows a machine built for feeding two chemicals as, for example, lime and alum.

Some of the advantages of installing a single unit machine that will do the work of a number of individual devices are: Reduced initial cost of apparatus, decreased installation expense, saving of space, less repairs and depreciation. The multiple machine may be calibrated and regulated in the same time that it takes to perform these operations on a single feed machine. As the multiple feed machine is operated by one drive unit, it is less noisy, simpler in construction, cheaper and easier to operate than a number of single feed devices. This type of apparatus is especially adaptable for use in small and medium sized water purification plants.



Multiple Dry Chemical Feeder

high speed performance and equipped with three rings; connecting rods interchangeable with Ford Model T rods; oiling by splash system; and high tension Wico magneto ignition.

These units will be furnished with any of the leading makes of diaphragm pumps, mounted on two wheel cushion tire trailer or four steel wheel trucks.

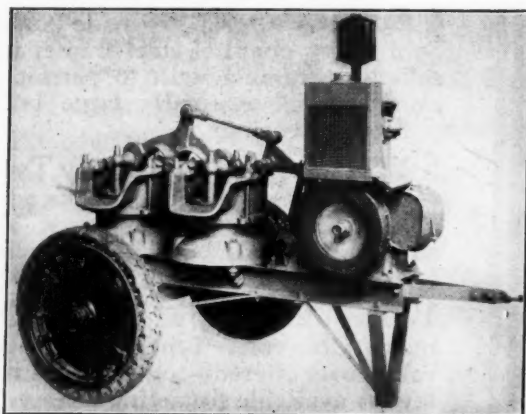
The neat compact construction results in light weight, only 775 pounds complete. The engine has a built-in gear reduction. One set of gears, which are carefully guarded operate the jack, which is of the walking beam type.

The engine has a speed range of 900 to 1800 r.p.m. with surplus power at all speeds. It can be speeded up to the maximum capacity of the diaphragm pumps giving the unit a capacity of 7000 to 9000 gallons per hour.

## A New Double Diaphragm Unit Pump

The John Lauson Mfg. Co., New Holstein, Wisc., announce a new double diaphragm unit with three-inch pump. A 2½ to 3-h.p. Lauson vertical radiator cooled engine furnishes the power.

Some of the features of the engine are: Mechanically driven flyball governor, enclosed in dust proof housing; crankshaft mounted in heavy duty roller bearings which are lubricated from engine crankcase; a heavy counter balanced crankshaft 1⅜ inches in diameter, balanced with counter weights; grey iron pistons, specially designed for



Lauson Double Diaphragm Pump Unit

## Highway Rear Dump Two-Wheel Trailer Scraper

The Highway Tractor Co., Edgerton, Wisc., has brought out a self-loading 2-wheel rear dump scraper which has a wide variety of uses. This is made in three sizes: 2-yard, for use with 20-horse power tractors; 3½-yard for use with 30 tractors; and 5½-yard for use with 60 tractors. It is claimed that with these units, dirt can be hauled for distances of 100 to 1500 feet more economically than by any other method.

The 3½-yard scraper, it is stated, will replace about 6 teams and 9 men.

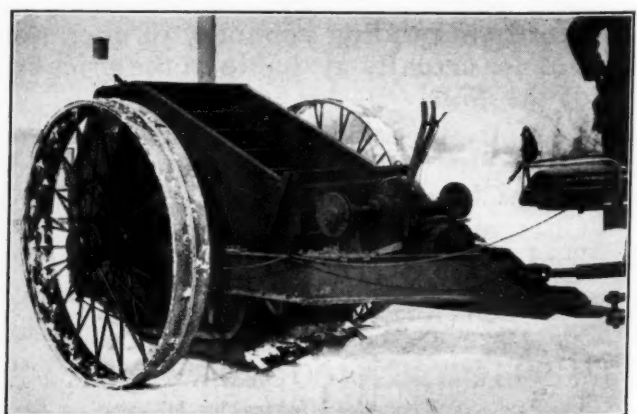
It is claimed that, on a 10-hour day, the 2-yard scraper will handle 175 to 200 cubic yards of soil an average distance of 300 feet; the 3½-yard scraper will handle 300 to 350 yards; and the 5½-yard scraper 500 to 550 yards. All this is done with one man. Under average conditions a load is picked up in one minute.

The entire outfit can turn, it is claimed, in a 24-foot circle, while the universal joint allows the tractor to turn at an angle of 110 degrees and still transmit power. The load, as it is dumped, is leveled by the dumping door.

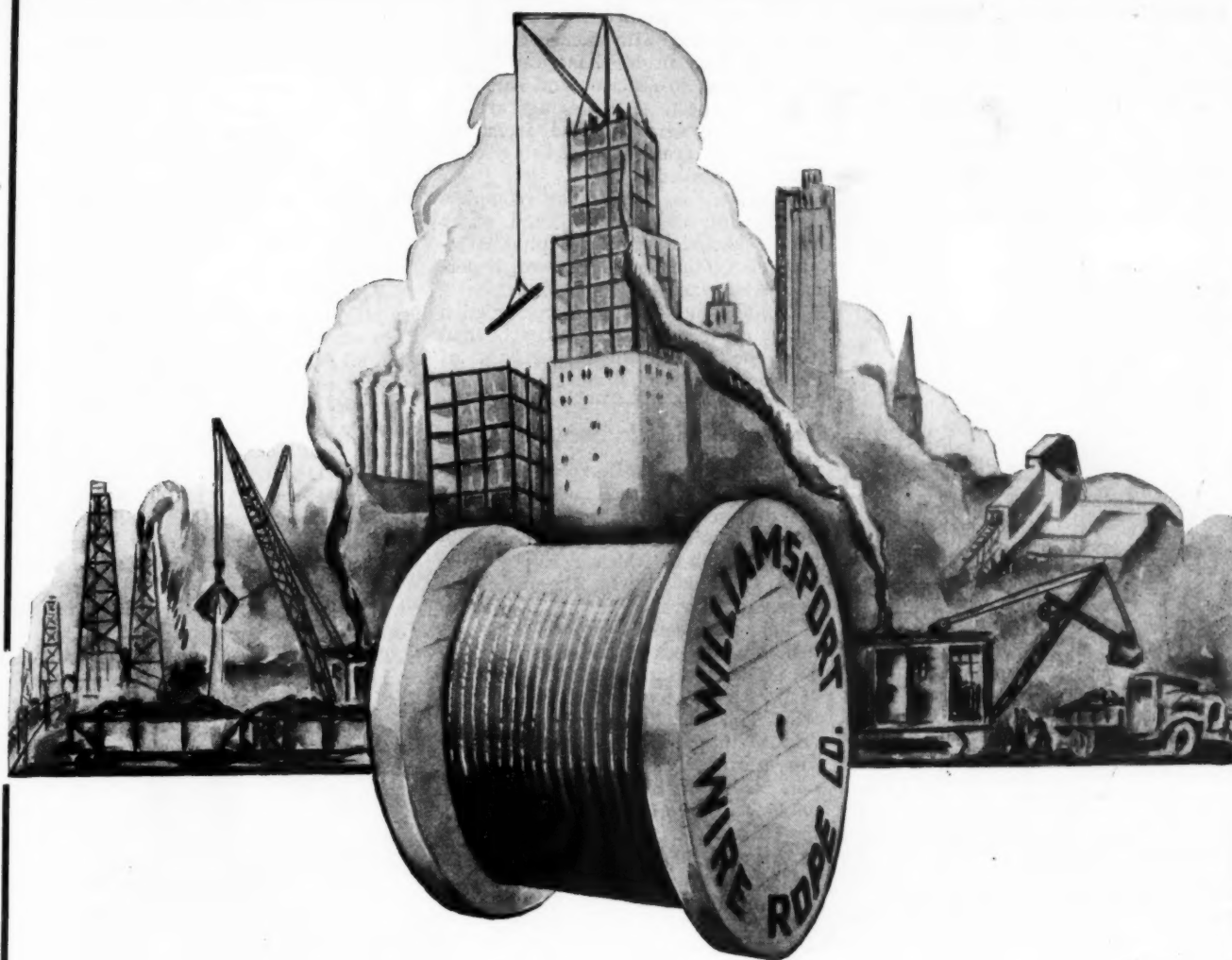
The Scarifier teeth and other wearing parts are of manganese steel.

## Steel Barricade Supports

The Cleveland Steel Specialty Corp., Cleveland, Ohio, has developed a steel barricade support, which has many advantages over the usual wooden support. These steel supports, while sufficiently heavy to resist wind pressure, can be handled easily by one man; they are adjustable as to width, self-locking, and very durable. They can be bent, but will not break, and are readily straightened. Transportation and storage is easy, and as a safety factor, eliminating the liability of imperfect barricades, they are valuable.



Highway Rear Dump Two-Wheel Trailer Scraper



*Wherever there's a need for the utmost in Precaution and Safety;  
Where the hazards of Guess and Chance Taking must be minimized*

USE

# WILLIAMSPORT WIRE Telfax Tape Marked ROPE Factory Certified

It is the only Wire Rope made that PROVES EVERY grade.

The method of manufacture; the high standard of tests, and finally the Telfax System of Tape Marking EVERY grade, so that the user may forever know the make, grade and strength of the rope he is using, has made Williamsport the outstanding Wire Rope in America among men who believe in, and practice "Safety."

Williamsport Wire Rope is made to meet a quality and safety standard—not a price. Safety Engineers depend upon it—so can you.

## WILLIAMSPORT WIRE ROPE CO.

Main Office and Works: Williamsport, Pa.

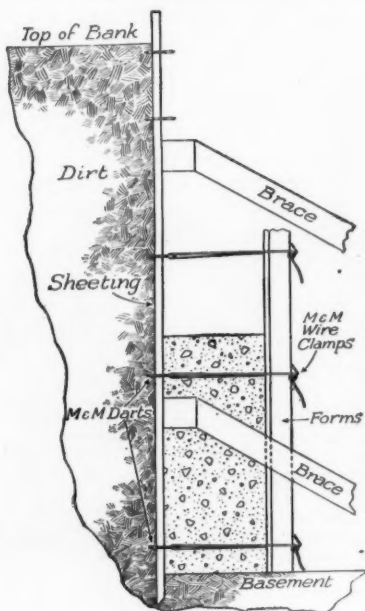
GENERAL SALES OFFICE: 122 SOUTH MICHIGAN AVE., CHICAGO

The Largest Exclusive Wire Rope Plant in America

Please mention PUBLIC WORKS when writing to advertisers.

### M&M Sheeting Darts

M&M Wire Clamp Co., Minneapolis, Minn., manufacture wire clamps for concrete form work, and also M&M sheeting darts, which are designed to attach the inside wall forms to the wood sheeting used to support an adjacent street or property. The sheeting is used as one side of the form for the concrete wall. When a single wall form is built it is an expensive and difficult job to



M&M Wire Clamps.

hold it in place when the concrete is poured as it necessitates much bracing and the forms necessarily have to be poured carefully and slowly on many occasions. Sheeting darts will save considerable money when constructing forms of this type and speed up the operation. They can be used in conjunction with the M&M Wire Clamps for holding the forms.

In use, they are driven between the boards forming the sheeting, and turned at a right angle; the tie wire is then looped in the eye and fastened.

### New American Deep Well Turbines

The American Well Works, Aurora, Ill., announce their new 6 in. and 8 in. deep well turbines. These turbines have been built in response to a demand for a turbine to fit smaller bored wells. The deep well turbine consists of the turbine head proper, which is the driving unit, the supporting pipe, which encloses the driving shaft, and the turbine itself, which consist of the number of stages necessary for the specific requirements.

The turbine head consists of the vertical motor mounted on a very rigid and compact base. The thrust bearing of the motor is designed to carry the load of the line shaft and impellers.

To the turbine head is attached the supporting pipe, to the lower end of

which is attached the turbine proper.

The turbine proper is a special style of the turbine type of centrifugal pump and is designed with the special features that have made "American" deep well turbines so efficient and satisfactory in the past. All bearings are oil lubricated by gravity feed from the surface, the gravity feed being electrically controlled.

Provision is made for complete drainage of all waste oil and water leakage and the discharge pipe is located above the floor level, which permits of easy access.

Engineering data and construction details of these turbines may be had from the engineering department of The American Well Works, Aurora, Ill.

### Genfire Rigideck Steel Roofing

The Genfire Steel Company, Youngstown, Ohio, manufactures a steeldeck roof design known as Rigideck. It is made in six-inch widths of Armco Ingot Iron, each of which locks rigidly to those adjacent to it. The distinctive feature of this roof is that it presents an unbroken smooth surface to receive insulating materials, and that it can be erected without any perforations of the steel. Each section is formed by the pressing of a patented self-locking rib section into a strip of Armco iron, giving rigidity to the section and providing bearing points to rest on the purlins of the building.

Other roofdecks to be made by Genfire are Ferrodeck and I-Plates, which also give smooth surfaces for insulation. Ferrodeck is recommended as peculiarly adapted for replacing outworn roofs of wood or other material on old buildings. I-Plates come in rigid two-foot sections, each with ribs formed in them at six-inch intervals. Cost of installing either Rigideck, Ferrodeck or I-Plates on any kind of building is said to compare favorably with any other roof construction.



M&M Sheeting Dart

### Jaeger Tubular Material Towers

The Jaeger Machine Co., Columbus, O., manufacture tubular material towers. Jaeger towers compete in cost with wood. They require less supervision in erection on the job, have less wind resistance, eliminate fire hazards and are far superior in strength. Towers can be erected for half a man hour per foot under average conditions. Records are available down to three-tenths of a man hour per foot.

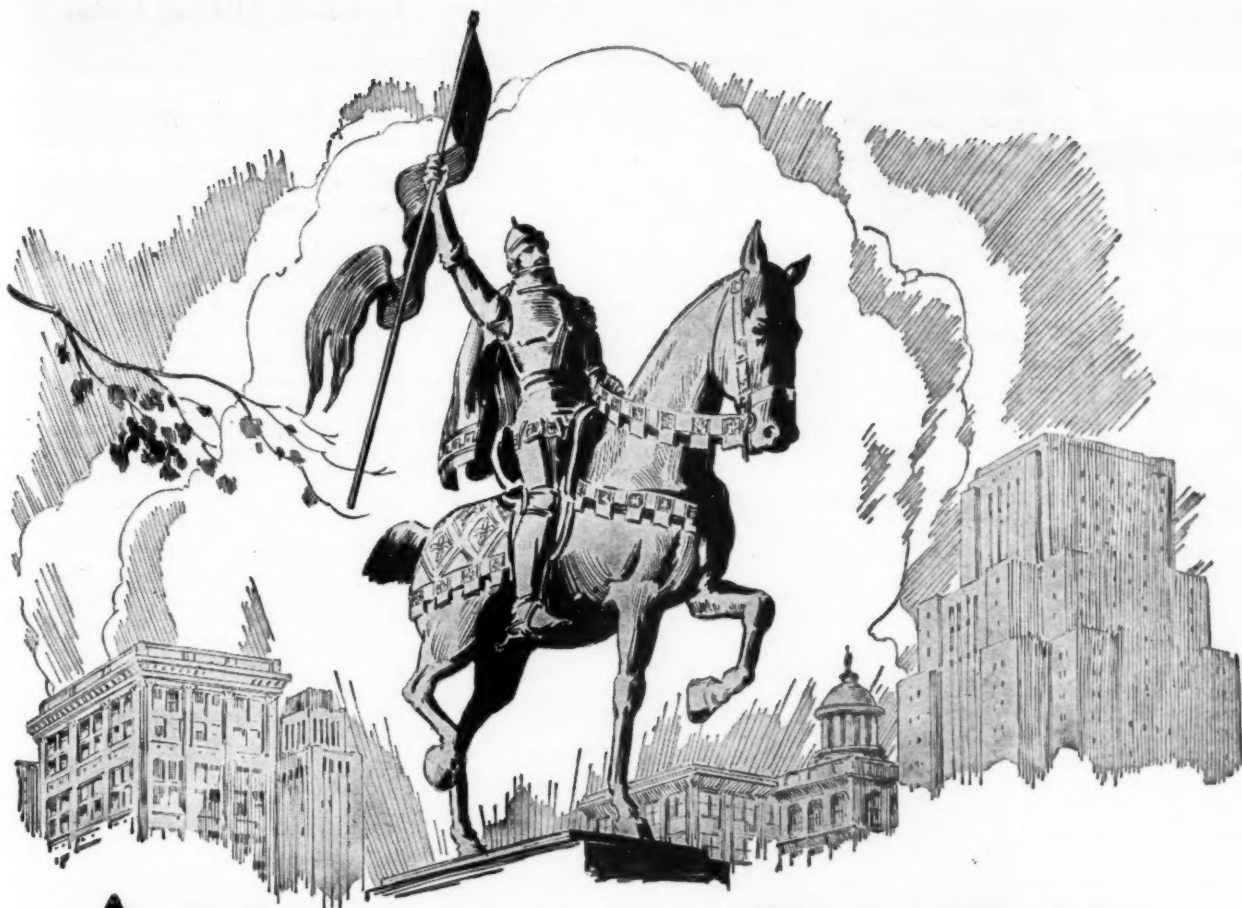
The tower is square in cross section so all girts are alike, all diagonal members are alike, all corner posts are alike, and all cage guides are alike. Top and bottom sections can be attached to any intermediate sections; the number of loose parts is kept to a minimum; maximum length of parts is only 6 ft. 6 in.

The standard single diagonal tower with platform cage is suitable for two wheelbarrow work. The smallest standard outfit has four sections giving 26 ft. height; to this can be added 16 more sections bringing the overall height up to 130 ft. The bottom sheave must be ordered extra as well as landing panels.

If desired, double diagonals can be added to carry the strain of an outside bucket giving the effect of a double tower.



American Deep Well Turbine



## A Monument to Civic Pride — *a Custodian of Health*

Where her richest, proudest avenues converge to form a square the city sets a stone, and on it rears a monument to her patriot sons.

In quite another quarter she erects a building that is no less a monument to her civic pride, though it be utilitarian to the last degree. That building is her Sterling Destructor plant, her means of sanitary waste disposal.

No city that possesses a Sterling Destructor but holds her head a little higher for that fact, for her air is clean. The Mutual-cell Furnaces of a Sterling Destructor burn both garbage and refuse, and in the burning completely oxidize the resultant gases, and leave only a little sterile ash.

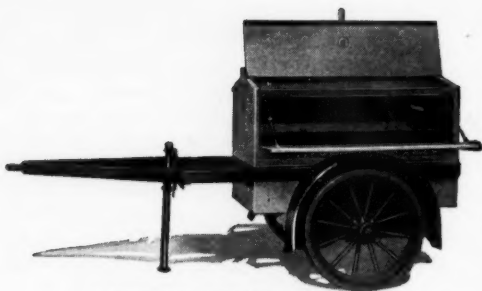
Read our Sterling Destructor booklet for a full report. Copies sent on request.

THE C. O. BARTLETT & SNOW CO.  
6221 Harvard Ave. Cleveland, Ohio



# Bartlett - Snow

## *Refuse Disposal Plants*



*Littleford Utility Steel Box*

### **Littleford All-Steel Heavy Duty Tool Box**

Littleford Bros., Cincinnati, O., has brought out a large portable steel tool box designed and constructed for highway maintenance departments, sewer, paving and bridge contractors, and public utilities. Jack hammers, drills, squeegees, smoothers, hoes, rakes, shovels, picks and all other equipment used in maintenance and construction work can be stored in this box.

The box is 8 feet long, 45 inches wide and 24 to 29 inches deep. It is made of 12 gauge steel and has a heavily reinforced bottom; heavy tools can be dropped into it safely and with no fear of injury to box. The box is large and roomy but not too deep (side wall is 2 feet high); tools and equipment can be arranged properly and easily found when wanted.

A strong deep shelf extends the full length of the box and is placed 19 inches from the bottom. Wrenches, hammers, saws and smaller equipment can be conveniently and safely stored on this shelf.

The double cover is water-proof, flanged on all edges, rigid and strongly hinged. When thrown open it is held firmly in place by a patented lock device which can be easily released, but cannot possibly let the cover fall until released.

Just in front of the tool box is a steel work bench 48x24 inches. It is built between the channels that form the chassis and is strong enough that vises or other bench tools can be mounted on it.

The chassis is made of 5-inch chan-

nels strongly braced by 5-inch cross headers and joined at the front end by an unbreakable cast steel pulling eye. It is mounted on semi-elliptical springs which absorb road shocks and permit rapid trailing. The 32x5 rubber tired wheels are equipped with Timken roller bearings. Shackle bolts have Alemite fittings.

Overall length of chassis from back to pulling eyes is 12 feet 3 inches. Overall width from hub to hub is 75 inches. Strong drop legs are placed at back and front; both are non-collapsible and when dropped in position will hold the box firmly in place. The rear drop leg is raised and lowered by means of a positive lock device. The front drop leg can be released, swung forward and fastened under chassis.



*Stockland Road Grader*

### **The Stockland Whippet One-Man Road Grader**

Foote Bros. Gear & Machine Co., Chicago, Ill., manufactures the Stockland Whippet road grader, which is claimed to possess unusual advantages for the road builder or maintainer. The Whippet is a pull-type grader, designed to be handled by an easily detachable tractor. It is light in weight, but strong enough to withstand heavy duty. It is claimed to be equally good for ditch construction and maintenance, light reconstruction, and general surface maintenance.

The Whippet will turn in a very short radius, less, it is claimed, than is required by the ordinary tractor. Low center of gravity is an important feature.

### **Littleford All-Steel Utility Box**

Littleford Bros., Cincinnati, O., have brought out an all-steel utility tool box. This box was designed primarily for public service companies, waterworks departments and fire departments and provides safety, protection of tools and equipment against theft, weather and fire; convenience of storage space with proper and logical arrangement of shelves; and a strong running gear built to stand rough, high-speed trailing.

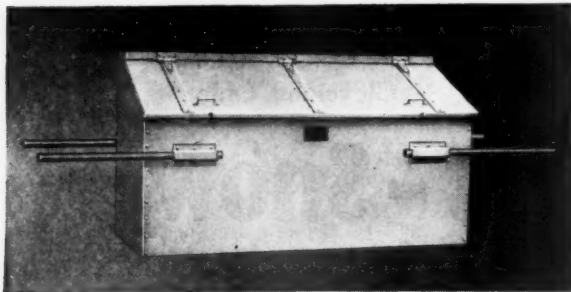
A feature of this tool box is that it can be completely opened up, affording easy accessibility to small, medium and large tools and equipment—but when closed it is absolutely water-proof and thief-proof. The cover, which opens on both sides, is flanged down and laps over the upper half of the side wall—cover and wall lock on one hasp. When open, the upper half of the side wall falls forward forming a convenient utility shelf; when up, it fits snugly with the flanged cover forming a completely weather-proof side. In order that the side walls will serve perfectly as shelves they are lined with oak, equipped with strong hinges and strongly supported at each side. The box being of all-steel construction is practically thief-proof.

Under the double cover is a large tray 54½ inches long and 36 inches wide. This tray is divided in the center by a metal partition, thus forming two separate shelves. Tape, solder, babbitt and small tools of all kinds can be stored here. When the cover is down the small tools are kept tightly in place—they cannot rattle around in the box or fall off the shelves. In this box all small tools can be placed in the top of the box, right at hand—the logical place for small tools and equipment.

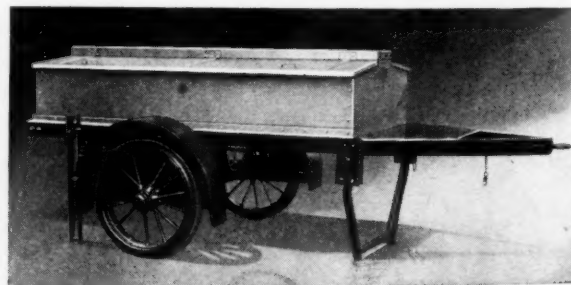
The large section of the box measures 54½ inches long, 36 inches wide and 30½ inches deep. It has a strongly reinforced bottom and is constructed for the storage of heavy equipment—melting furnaces, lead pots, oil cans, rolls of wire, picks, large pipe wrenches, etc.

A 12-inch wide tray, 20 inches from the bottom of the large section, extends the full length of the box. It is placed for convenient handling of medium sized tools and smaller equipment, particularly frequently needed tools.

In front of the box is a work bench. It is built between the two channels forming the chassis. Many small jobs



*A Stationary Tool Box by Littleford*



*Littleford Steel Heavy Duty Tool Box*

# Dependable Power for Every Purpose

## QUICK TRANSPORTATION

**T**HE ease with which lumber and pipe can be transported with Ross Carriers, manufactured by The Ross Carrier Company, Benton Harbor, Mich., means proven economy in getting materials to jobs quickly. Hence, greater satisfaction for the builder, more business for Ross users.

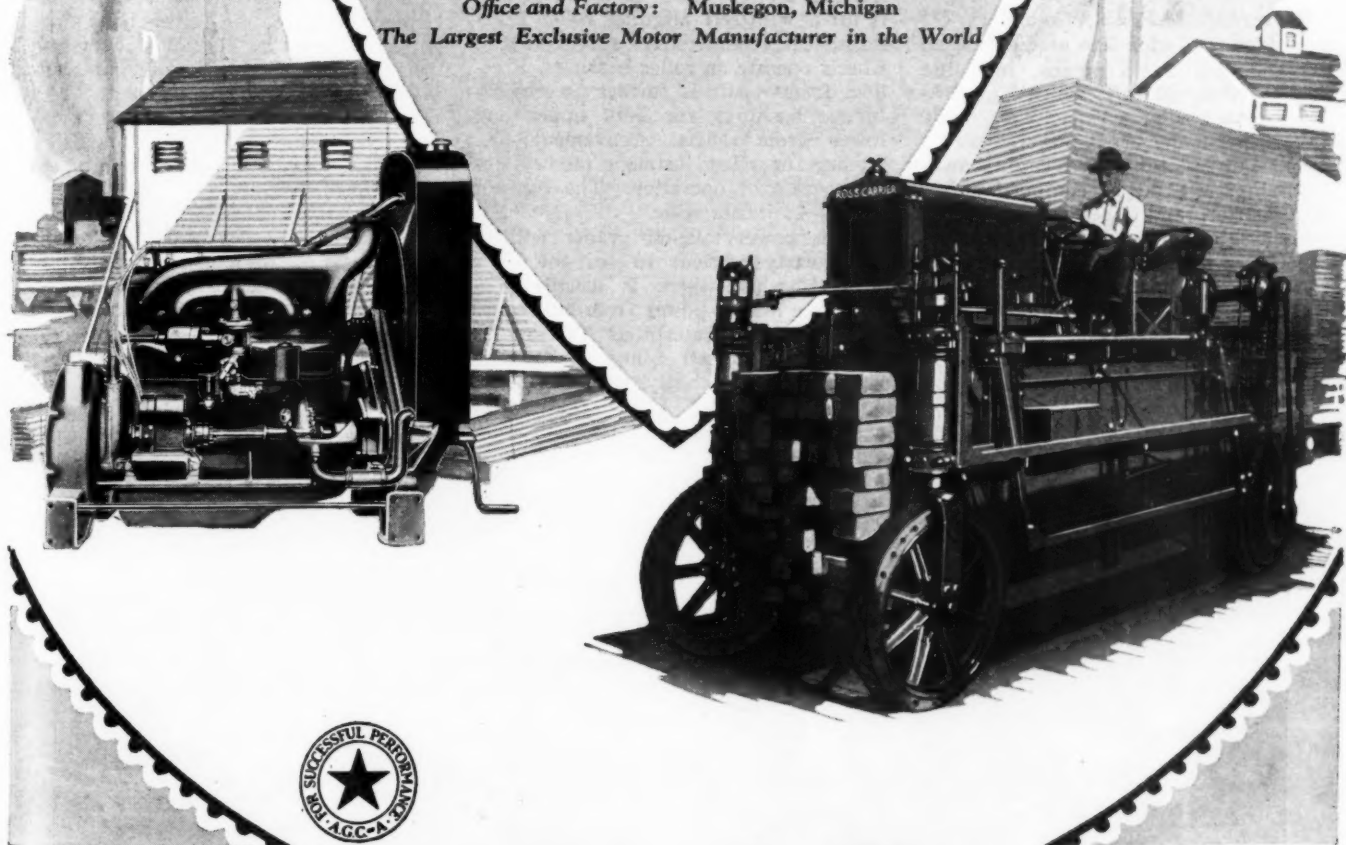
The fact that these carriers are powered with heavy duty Continental Industrial Engines is a decided factor in the stability of this equipment.

CONTINENTAL MOTORS CORPORATION

INDUSTRIAL EQUIPMENT DIVISION

Office and Factory: Muskegon, Michigan

The Largest Exclusive Motor Manufacturer in the World



# Continental Engines

Please mention PUBLIC WORKS when writing to advertisers.

can be performed on this bench. To further its utility it can be equipped with a pipe vise.

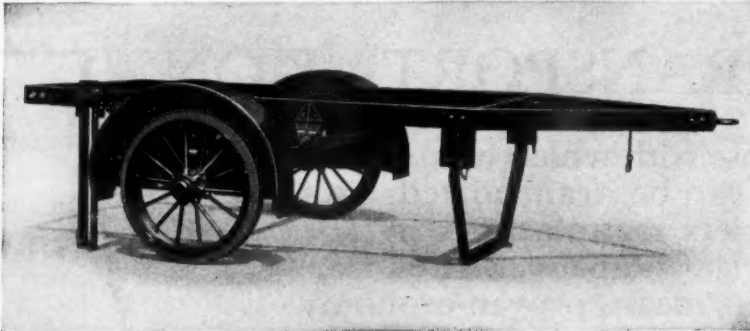
The chassis is made of 3-inch channels cushioned on heavy helical springs with 32x3 rubber-tired steel wheels equipped with heavy duty roller bear-

### "Caterpillar" Announces New Elevating Grader

The Road Machinery Division of the Caterpillar Tractor Co. now has ready for the market the Russell Sixty Elevating Grader. It has a greater capac-

elevating grader, yet it operates with a considerable saving of fuel.

This grader has just had a gruelling tryout on Mississippi levee work in the notorious buckshot soils encountered there, which proved its stamina.



*Littleford Two-Ton Trailer Chassis Can be Hauled Behind Trucks*

ings. A stiff leg at the front of the box made of 1¼-inch double extra heavy pipe is non-collapsible and can be securely locked in position. Because of the easily adjusted lockpin, the stiff leg can be lowered easily to support box or raised out of the way for trailing. The front end of the chassis has unbreakable cast steel pulling eye.

### Jaeger Speed Boy

Jaeger Machine Co., Columbus, O., manufacture a wide line of diaphragm, lift and centrifugal pumps, including the Jaeger Speed Boy, which is a portable pump having a capacity of 8,000 gallons per hour. It is powered with a 2-hp. 4-cycle high speed engine made by Briggs & Stratton, equipped with a foot starter, and direct coupled to a non-clogging pump having a Jaeger open type brass impeller. It is claimed that it will handle 25 to 28 per cent of solid matter such as sand, mud or small stones. It has no primer. This pump is very compact and can be handled by one man or carried by two easily.

ity than any other model previously put on the market by "Caterpillar" and is in line with that company's policies of building a better product for the consumer.

This machine is built for power take-off only and no provision for bull gear drive has been made. Elimination of the wheel drive makes the construction stronger and simpler. The Russell Sixty weighs 12,800 pounds. The line shaft is 2 7/16 inches in diameter and is fitted with self aligning roller bearings. The countershaft sprockets and wheels operate on roller bearings. Freedom from repair is further assured by bronze bushings for both upper and lower drum shafts. Convenient foot latches for all adjustment ratchets increase ease of operation. The elevator belt is 42 inches wide.

This power take-off grader will be particularly efficient in soft or loose ground, where there is usually considerable loss of power from bull wheel slippage. The Caterpillar Tractor Co. claims the Russell Sixty has greater capacity and mobility than the usual

### New Whippet Six-Cylinder Commercial Car

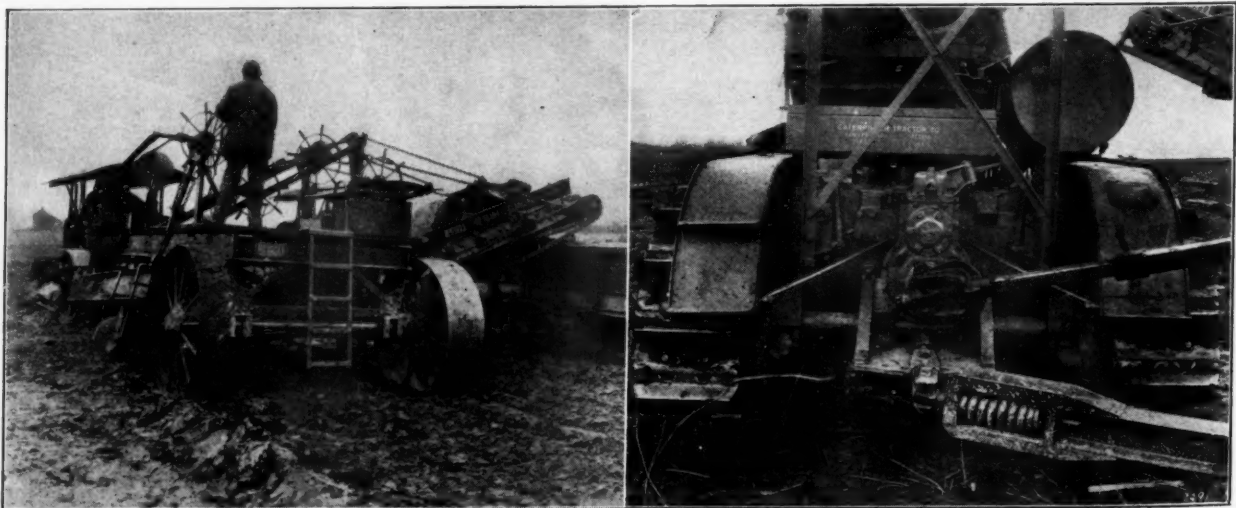
The Willys-Overland Co., Toledo, O., has announced a new line of Whippet Six 1½-ton commercial cars. Outstanding mechanical features include four-speed forward transmission, heavy seven-bearing crankshaft, Invar-strut pistons, full force feed lubrication, timing chain, four-wheel brakes, and a chassis of exceptional sturdy construction.

The heavy seven-bearing crankshaft is an important feature and is admittedly essential for the smoothest possible operation of a six cylinder engine. This crankshaft is drilled for full force feed lubrication, and is an innovation in the construction of commercial cars selling in this classification.

The Whippet six chassis, which has a wheelbase of 131 inches and is built with six cross-members, is designed to accommodate a wide range of body types such as a panel body, fully enclosed with two wide rear doors; the canopy top body with curtains at the sides and at the rear to provide protection for merchandise against inclement weather; the screen body type for much the same line of work as the canopy top, but with the added advantage of protecting the contents from theft; a stake body for contractors, express companies, factories, foundries, wholesalers and farmers, providing an extra large capacity.

The design of the radiator, lamps, etc., follows the standard style of the Whippet Six passenger cars. Automatic windshield wiper, rear view mirror, and automatic stop and tail light are standard equipment.

The six cylinder power plant with a bore of 3⅞ inches and a stroke of 3⅞



*New Russell Sixty Elevating Grader by "Caterpillar," Showing Grader in Action and Power Take-Off*



# ANNOUNCING

## THE 6" & 8"

### AMERICAN

### DEEP WELL

### TURBINES

The new 6 in. and 8 in. "American" Deep Well Turbines are ready.

Complete engineering data is now available.

The turbine head proper has great rigidity and compactness. Provision is made for complete drainage of all waste oil and water leakage. The discharge is located above the floor level. The motor is fixed directly above and to the pump shaft, and is furnished for alternating current.

The turbine proper is a special style of the turbine type of centrifugal and consists of one or more stages of suitable diameter to enter bored wells of 6 in. and 8 in. inside diameter. The number of stages may be varied according to the head required.

The supporting pipe is made up in 10 ft. sections fastened together with steel screwed couplings.

All bearings are oil lubricated by gravity feed from the surface, the gravity feed being electrically controlled. The lower bearing of the turbine is of the peg type and a motor thrust bearing is provided to carry the load of line shaft.

Bulletins giving complete details of mechanical construction and performance under various conditions are now available, and will be furnished on request.

**Branch Offices:**  
CHICAGO, ILL. 1615 First National Bank Bld. NEW YORK CITY Room 523 - 165 Broadway LOS ANGELES, CALIF. 416 E. Third St.

**District Sales Agencies:**

Boston, Mass.	Joplin, Mo.	Philadelphia, Pa.
Detroit, Mich.	Atlanta, Ga.	Kansas City, Mo.
Tulsa, Oklahoma	Dallas, Texas	Louisville, Kentucky
Denver, Colorado	Cleveland, Ohio	St. Paul, Minn.
St. Louis, Mo.	Charlotte, N. C.	San Francisco, Calif.
Omaha, Nebr.	Pittsburgh, Pa.	El Paso, Texas
Birmingham, Ala.	Roswell, N. Mex.	Salt Lake City, Utah
Portland, Maine	Portales, N. Mex.	Vancouver, B. C., Canada

## THE AMERICAN WELL WORKS

General Offices AURORA, ILLINOIS and Factory

inches is employed in the commercial line and develops 50 horsepower at 3,000 r.p.m. The chassis lists at \$645 at Toledo.

### Arco Metal Pipes and Fittings

The American Radiator Co., New York, has brought out Arco metal pipe, which is made from a special analysis

priming are eliminated. In addition starting difficulties are also eliminated as the water begins to flow immediately after the motor is started.

The automatic shutoff prevents the pump from burning out on the job. A workman can start it and can go away and forget it; a safety device short circuits the magneto of the motor when water is not passing through the pump.



*Johnson Drainage Pump*

ni-chrome alloy iron cast by a process which is said to give the product greater ductility and tensile strength; and, also, due to the close grain structure, greater corrosion-and erosion-resisting qualities.

Arco metal pipe is a threaded joint cast pipe made in the following sizes: 1½-in., 2-in., 2½-in., 3-in., 4-in., 5-in. and 6-in. with the same outside and inside diameters as extra strong wrought steel or iron pipe. (8-in., 10-in. and 12-in. will be available later.) Lengths are approximately 6 feet. Longer sections can be furnished.

Arco pipe can be cut and threaded at any point within its own length with all standard tools which are used on wrought steel or iron pipe and does not have to be reamed after cutting.

Each length is tested by hydrostatic pressure, the test ranging from 300 to 1,000 pounds per square inch.

The pipe has the following properties, it is claimed: It is true to dimensions, smooth outside and inside; it is free from casting strains; it is uniform in wall thickness; all standard flow tables for extra strong wrought steel and iron pipe can be used to figure the capacity; it is very resistant to both corrosion and erosion and will not scale inside, cutting down the flow area.

A full line of fittings is available.

### New Drainage Pump Operated By Outboard Motor

A new type drainage pump which is powered with a Johnson Outboard motor and which is self-priming and will shut itself off when the supply of water to be pumped is exhausted is manufactured by the Johnson Motor Company, Waukegan, Illinois.

This pump consists of a long pump shaft with a light twin cylinder outboard motor mounted on the top. This motor drives the impeller which is located at the bottom of the shaft. As the impeller is always submerged no air can be sucked while there is still water to be pumped. Thus delays in

Uses for this pump include pumping water from excavations, concrete forms, manholes and barges. It is also useful in dredging work of all kinds. It will pump 195 gallons of water per minute and 1,000 gallons for the approximate cost of one cent.

Contractors find it valuable in cutting down transportation expenses. Where a truck might be necessary in transporting other pump equipment from one job to another, this pump, weighing only 85 pounds, can be carried by a laborer. If long distances are involved it can be placed on the side of an automobile.

### Improved Littleford Traffic Line Marker

Littleford Bros., Cincinnati, O., have made a number of improvements in their Traf-O-Mark line marker. These include a flexible metal hose with valve control and pump which can be detached easily and quickly for cleaning; a paint reservoir with extra clearance

and increased head, eliminating priming and making the flow more positive; a guard over the brush to keep pebbles and dirt from flying onto the marking roller; and a scraper at the rear of the marking roller which removes any pebbles or dirt picked up by the roller.

### Starrett Cable Cutter and Cable Band

The Morse-Starrett Products Co., Oakland, Calif., manufacture the Starrett steel band and cable cutter which introduces a new method of binding or seizing and cutting steel cable. Any grade or size of cable up to one inch may be seized or whipped and cut by one man in less than one minute, and both cut ends of the cable will be left incased in a steel band and substantially of the same original diameter as the cable.

The Starrett steel band is a thin sheet of pilable but very tough steel indented with a groove and lock seam at one edge and is made in lengths and sizes to fit the various sized cables. Its application is simple, requires no special tools, and may be made in 20 seconds.

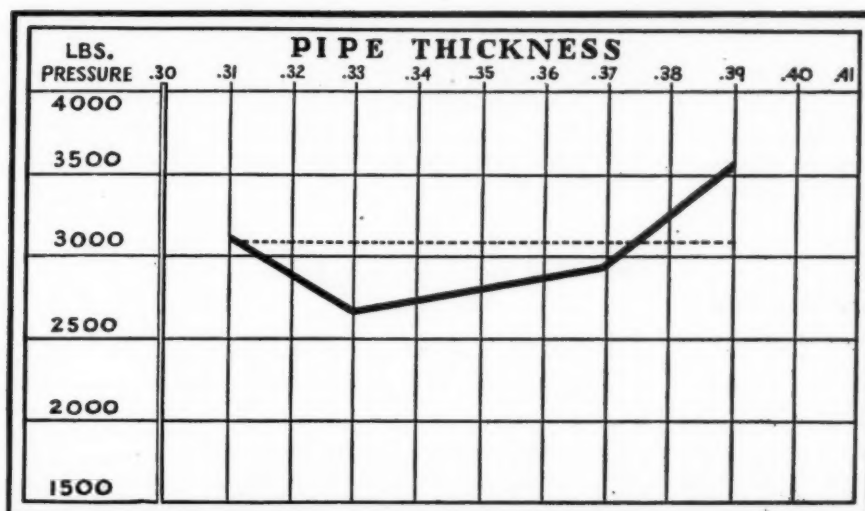
The Starrett cable cutter is designed to cut cable with the minimum of effort and is particularly adapted to be used with the Starrett band, as its peculiarly shaped cutting blade and die prevents flattening of the cable in the process of cutting, and retains the natural shape and lay of the strands.

Cutting through the center of the band leaves both cut ends confined in a steel band or sleeve. It is an ideal whip, or seizing, as it not only cinches, in the process of cutting, the lay of the strands in their proper position but prevents unraveling of the cut strands so that the cut ends may be immediately passed through any fitting or fixture with which it is intended to be used.



*Littleford Improved Traffic Line Marker*

# \*deLavaud pipe shows an average internal resistance of 3090 lbs. per square inch



\* The above graph is based on tests performed by a well-known Testing Laboratory. These tests show that deLavaud Pipe is over 25% stronger than good pit cast pipe. The dotted line represents the average bursting pressure of 6" deLavaud pipe of representative thicknesses.

**T**HE superior strength of deLavaud pipe becomes more surprising when one considers the increased carrying capacity which this pipe offers. On the graph shown above, you will note that the average thickness of the deLavaud pipe tested is thirty-five one-hundredths of an inch. Yet, this pipe exceeds by 25% the strength of any pit cast pipe designed for equal working pressures.

deLavaud pipe is made by pouring molten metal into a cylindrical mould which is revolving at a high rate of speed. Centrifugal force holds the metal against the mould and drives out impurities with a force 40 times greater than gravity.

Therefore, deLavaud cast iron has a dense close-grained structure and

freedom from gas bubbles and impurities. In addition, the quick cooling of the surface metal in the deLavaud water-cooled mould helps bring about the finely divided condition of the graphite in the iron.

So remarkable have been the results of strength tests conducted on deLavaud Pipe that it is difficult to describe them without using extravagant-sounding comparisons. Suffice it to say that the great strength of deLavaud has never been equalled by any pit cast pipe.

Let us send you further facts and figures about deLavaud Pipe. Our free, illustrated handbook gives detailed information regarding types of joints and dimension tables. Write for your copy today.



Cast iron pipe made by this Company bears the "Q-check" trademark of The Cast Iron Pipe Research Association.

## United States Pipe and Foundry Co., Burlington, New Jersey

Sales Offices:  
New York

Philadelphia  
Pittsburgh

Cleveland  
Buffalo

Chicago  
Dallas

Birmingham  
Kansas City

Minneapolis  
Seattle

San Francisco  
Los Angeles

### Duplex One-Man Motor With Patrol and Grader

The Duplex Manufacturing Co., Omaha, Nebr., has brought out a new one-man motor patrol equipped with McCormick-Deering industrial tractor and rubber tires. This machine is especially simple and rugged and has a blade control, which, it is claimed, will raise or lower the blade as desired with a touch of the hand, yet the blade cannot ride over bumps nor drop into holes and depressions. Tractor speeds run from 2 to 10 miles per hour.

The wheel base of this grader is 15 feet and the overall length 18 feet. The weight with tractor is 11,000 pounds, and of the grader only 3,350 pounds. Blades can be furnished in 10, 12, 14 and 16 foot lengths; the blade shift is 12 inches each way, and the clearance when the blade is lifted is 12 inches.

### New G. E. Insulating and Protecting Coating

For sealing joints in gas mains, for painting structural iron, motors, oil tanks, metal parts of ships exposed to oil or vapors, fire hydrants, ship hulls, mine machinery and similar equipment requiring sealing and insulating paints, the General Electric Company is offering a series of lacquers in colors, for use where an oil-resistant, highly protective, durable and flexible insulating coating is demanded. The base of the new lacquers is an alkyd resin and glycerine and marketed under the trade name "Glyptal."

These paints possess many desirable qualities, including resistance to acids, mineral oils, weather, and alkalis, tenacious adhesion to any surface—including galvanized iron and aluminum—and protection against rust. The Glyptal lacquers have been found superior to ordinary protective paints, in that they are more easily applied, dry faster to a coating of more pleasing appearance, are more resistant to acids and mineral oils, and are less affected by high temperatures. They withstand temperatures destructive to, and have a dielectric strength greater than, the commonly used paints.

These new lacquers are now available in five colors—red, blue, brown, green, and aluminum. They may be applied by brushing, spraying, or dipping, dry dust free in about 30 minutes, and in approximately ten hours to a hard, smooth finish which is not brittle and which is easily cleaned. When using Glyptal lacquers as a finish, no priming or sizing is necessary.

All Glyptal lacquers have basically the same characteristics. The No. 1201 red Glyptal lacquer, however, is recommended for most effectively sealing joints against oil, water and gas leaks. It adheres strongly to metals, protect-

ing them against corrosion, and has a pleasing appearance and high dielectric strength. It is superior to G-E No. 880 red protective paint, formerly marketed for these requirements.

Blue, brown and green Glyptal lacquers, No. 1206, 1210, and 1211, respectively, are primarily for finishing purposes. Aluminum Glyptal lacquer, No. 1212, withstands extremely high temperatures, and tests show that discoloration is practically imperceptible at 600° F. It is recommended for use on metal subjected to high temperature. This lacquer is of a light-reflecting color, and has been used advantageously to brighten poorly lighted shops.

Glyptal lacquers have been placed on the market by the Merchandise Department of the General Electric Company, Bridgeport, Conn., in half-pint, pint, quart, one- and five-gallon cans, and 52-gallon drums.

### Improved Clark Meter Testing Machine

The H. W. Clark Co., Mattoon, Ill., has announced a slight change in the Clark Meter Testing Machine for testing the accuracy of water meters.

The electric alarm bell which has been used to signal the closing of the test on water meters has been replaced by an electric buzzer. In several cases where the Clark Meter Testing Machine was located near the telephone, it was difficult to distinguish between the bells.

The electric buzzer on the Clark Meter Testing Machine is quite an aid in the testing of meters on small flows.

In testing on a small flow or on quantity tests, for accuracy, the oper-

ator may leave the machine and occupy himself with other duties. The electric buzzer calls the operator a few seconds before the close of the test.

### Superior One-Yard Body With Power Hoist

The Superior Body Corporation, Marion, Ind., have brought out a one-yard body for the Ford Truck. The body is one yard capacity, water level, and by increasing the height of the end and tail gates, so that sideboards can be added, if desired, the capacity can be increased to one and one-half or two yards. The tail gate is double acting and the operation of the body is controlled by the driver in the cab. The unit may be mounted with or without cabs.

The mechanism is so arranged that the bodies can be raised to a forty-five degree dumping angle in three to five seconds time.

The latch which is installed on this unit is automatic in action and is guaranteed to give entire satisfaction. The body is tapered to facilitate unloading and is made of ten gauge blue annealed steel body sheet.

When the body returns to normal position the power take off is automatically thrown out, or released.

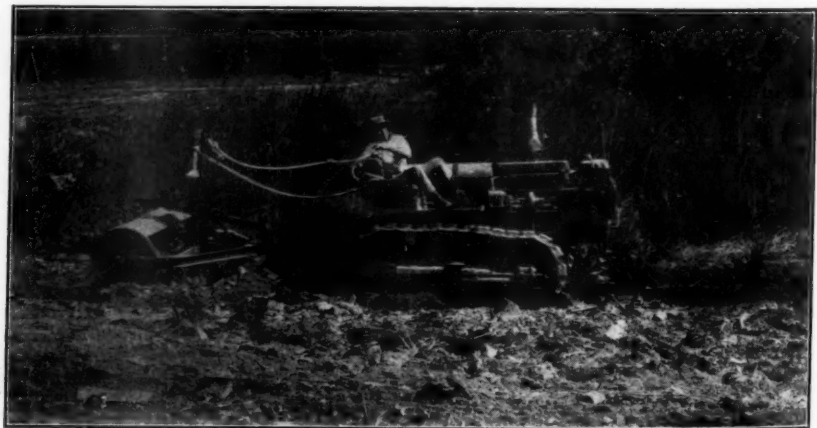
By incorporating the Self-Dumper under-structure and adding the Superior mechanical hoist with power take off, this unit operates very easily in action, due to the fact that the hoist is not required to lift more than 10% of the load, inasmuch as the load in dumping functions on a semi-gravity principle.

This unit gives a most satisfactory mounting from the standpoint of weight distribution on truck chasses.

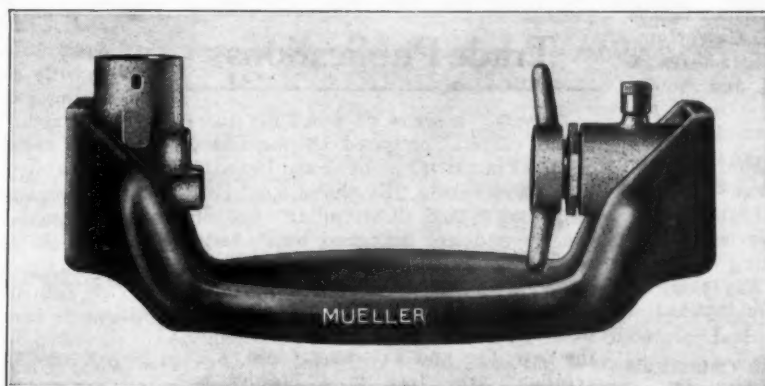
### Converting a Mosquito Swamp Into Fair Grounds

A fleet of county-owned "Caterpillars," with scrapers and grading machinery converted a 103-acre swamp at North Bakersfield, Cal., into a park, on which has been constructed exhibition buildings. Mosquito control has been an important by-product of the change. Many cities have mosquito

producing areas that can be converted cheaply and quickly, with modern construction machinery, into revenue or pleasure-producing assets to the community. Dumps, swamps and other eyesores and liabilities often require but little effort for their complete elimination.



"Caterpillar" and Revolving Grader Eliminating Mosquito Producing Area



# NEW!

## Mueller Improved Meter Yoke

**T**HE new Mueller Yoke Plate No. G-10630 was designed after a complete study of all types of meter yokes on the market. It is a one-piece yoke with no bolts to rust, which drops vertically on the risers. Every feature conducive to ease of installation, flexibility, adaptability, and long life and satisfaction is embodied in this yoke.

It is very simple to install and after installation there is nothing to slip or get out of alignment.

The stop in the yoke has been given special thought because we realize it is the only

means of controlling the water between the Main and the House. The outlet connection or ell, which in itself is a stop, was so designed that the sleeve can be screwed back to its limit, which forms a stop preventing a drain from the house.

This yoke may be used with any meter now on the market. Send for special information.

MUELLER CO. (Established 1857), Decatur, Illinois; *Branches:* New York, Dallas, San Francisco, Los Angeles; *Canadian Factory:* MUELLER, Limited, Sarnia.

# MUELLER

## PLUMBING BRONZE AND VITREOUS WARE

## Industrial Notes

The corporate name of the J. I. Case Threshing Machine Co., Racine, Wisc., has been changed to J. I. Case Company. The company manufactures a large line of agricultural and power implements.

Ross W. Judson, President of Continental Motors Corporation, has announced the opening of a branch office of the company in Los Angeles to take care of its rapidly growing business west of the Mississippi. Ray Long is Western district manager.

The Chicago office, the American Hoist & Derrick Co., St. Paul, Minn., which has been located at 1113 Fisher Building has moved to 1000 Engineering Building at 205 W. Wacker Drive. The Pittsburgh branch is now located at 901 Farmers Bank Building instead of 604 Chamber of Commerce Building.

The Central Iron & Steel Company of Harrisburg, Pa. has announced changes in the location of its New York and Pittsburgh offices. The New York district office, formerly in the Evening Post Building, is now located in Suite 516 in the new Cunard Building at 25 Broadway. The Pittsburgh district office has been removed from the Commonwealth Building to more suitable quarters at 1721 Oliver Building.

The Union Metal Manufacturing Company, Canton, Ohio, announces the opening of three new District Offices. These offices will serve as sales headquarters for Union Metal Steel Lighting Standards, Fluted Steel Poles, and Exterior Lighting Fixtures and King Ferronite Lighting Standards. The Southeastern District Office is in charge of C. A. Williams, 1508 Candler Building, Atlanta, Ga. L. Mitchell has

charge of the Southwestern Office with headquarters at 278 Allen Building, Dallas, Texas. The Boston Office is managed by E. H. Bradley, 378 Stuart Street, Boston, Mass.

## Trade Publications

*"Roads,"* a series of five fully illustrated folders, prepared by the Caterpillar Tractor Co., of San Leandro, Calif. and Peoria, Ill., shows what Russell graders and "Caterpillar" tractors can do and are doing to build better roads quicker and cheaper.

*Tractors*—The design, construction details and complete specifications of the new Ten and Fifteen models "Caterpillar" are given in a booklet recently published by the Caterpillar Tractor Co. of San Leandro, Calif. and Peoria, Ill.

*Sprocket Wheels*.—Link-Belt Company of Chicago and Philadelphia has just issued a 38-page book, No. 1167, showing detailed specifications of the 15,000 sprocket wheels they now carry in stock. This will be sent free on request.

*Diesel Driven Air Compressors*.—The Sullivan Machinery Company has just published a new booklet, No. 83-L, entitled "Sullivan Angle Compound Air Compressors Direct Connected to Diesel Engines." In this booklet will be found many illustrations of Diesel engine compressor plants, which have been installed in all parts of the country for many different kinds of service, both mining, construction, and industrial.

*Chlorinating Devices*—The Paradon Mfg. Co., Arlington, N. J., has issued Engineering Bulletin No. 20, describing the Paradon Chlorinizer, a chlorinating device for small water supplies, swimming pools, and sewage plants such as those of small municipalities, factories, camps, estates, country clubs, hotels, etc.

*Pony Ditcher*.—The Industrial Brownhoist Corporation, Cleveland, O., tells about their light-weight crawler mounted trench digger which saves money on small trenching jobs.

*Road Graders*.—The Austin-Western Road Machinery Co., Chicago, Ill., has recently published Bulletin W-29-J, describing the No. 22 Leaning Wheel Grader, and Bulletin W-29-D, describing the No. 55 Road Grader.

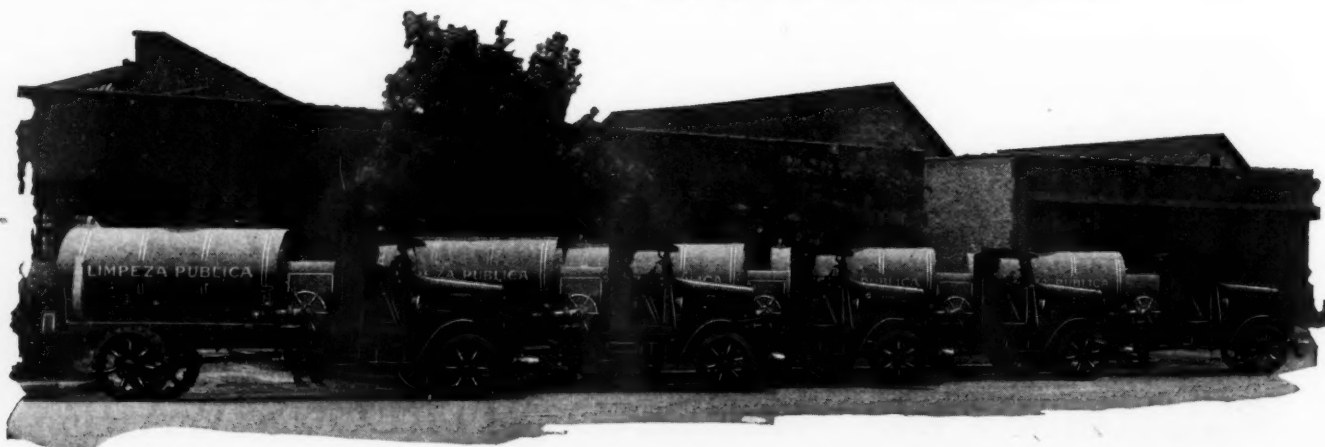
*Construction Equipment*.—Zelnicke's Bulletin No. 375 lists a very large supply of new and second-hand equipment of all kinds. 32 pages, illustrated. W. A. Zelnicke Supply Co., St. Louis, Mo.

*Road Machinery*.—The Good Roads Machinery Co., Kennett Square, Pa., has issued new bulletins describing the "Motograder," the "Autograder," road rollers, and the cold application oil distributor.

*Under Drains*.—The use of Toncan Iron in perforated, corrugated iron underdrains is described in booklets recently published by the Canton Culvert & Silo Co., Canton, O., and the Toncan Culvert Manufacturers' Association, Massillon, O. Both booklets deal with the general problems of drainage, and contain technical and practical discussion of the design and application of Toncan copper molybdenum iron drains.

*Chains*—An interesting and helpful pamphlet, bearing the above title has just been issued by American Chain Company, Inc. It contains tables showing the number of links per foot, weights, proof tests and safe working loads of the different sizes of crane or dredge chain and other information which buyers and users of chain will find valuable for their files. Copies may be obtained, without charge, by addressing a request to American Chain Company, Inc., Bridgeport, Conn.

## American Street Cleaning Equipment in South America



A Part of the Fleet of International Street Flushers Operated by the City of Rio de Janeiro.

# Only 4 Working Parts

WESTCOTT Hub End Valves exceed the requirements of the AMERICAN WATER WORKS ASSOCIATION Specifications.

## Tensile Strength

American Water Works Association specification  
 .....Gray Iron, 22,000 pounds per square inch  
 Westcott Semi-Steel average tensile strength  
 .....35,000 pounds per square inch

## Tensile Strength of Stems

American Water Works Association specification  
 .....60,000 pounds  
 Westcott Manganese Bronze Stem.....85,000 pounds  
 All weights of Westcott Valves are equal or more than

the specifications of the American Water Works Association, and they have much greater strength due to the use of Westcott Semi-Steel instead of gray iron.

**WESTCOTT Semi-Steel means greater strength.**

This metal is the result of many years of testing various mixes and alloys. We own our foundry and are thus able to guarantee the constant quality of this metal that is superior to all others for Hub End Valves. The men who run the Westcott Foundry have spent a lifetime developing this special metal—Westcott Semi-Steel.

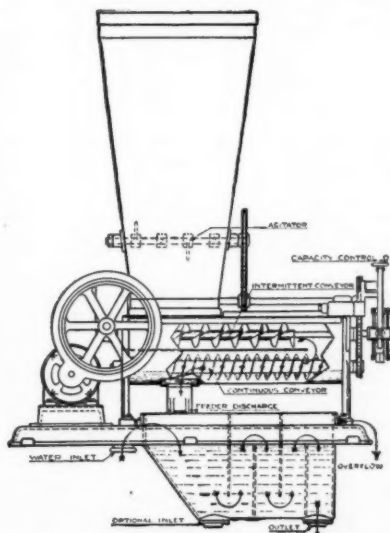
WESTCOTT VALVE CO., EAST ST. LOUIS, ILL.

# WESTCOTT VALVES

The New Series

## SAVAGE-GAUNTT DRY CHEMICAL FEEDER

The Standard  
 For Feeding  
 Any  
 Dry Material  
 Such As  
 Hydrated Lime  
 For Water  
 Purification



"A SAVAGE PRODUCT"

**W. J. SAVAGE COMPANY**  
 KNOXVILLE TENNESSEE

*for*

Water Sterilization  
 and Sewage Disposal



## Liquid Chlorine

A valuable illustrated booklet,  
 "Liquid Chlorine in Sanitation"  
 will be sent free upon request.

*Your water and sewage  
 deserve the best treatment.*

**Electro Bleaching Gas Co.**  
 PIONEER MANUFACTURERS OF LIQUID CHLORINE

Plant: NIAGARA FALLS, N.Y.

Main office: 9 East 41<sup>st</sup> Street New York

**Tractors.**—New Model LH Trackson Full-Crawler for the McCormick-Deering 10-20 Industrial Tractor. This is especially adapted for use with one-man graders, but also available for a wide variety of other uses. Trackson Co., Milwaukee, Wisc.

**Hydrogen Ion Control.**—The La Motte Chemical Products Co., Baltimore, Md., has just issued the 5th and

enlarged edition of the A. B. C. of Hydrogen Ion Control. 132 pp., Ill. Copies will be sent on request.

**Altimetry.**—The Technical and Educational Departments of The American Paulin System, Inc., Los Angeles, California, have compiled a 16-page manual on Altimetry, treating with the subject of altimetry as it applies to all phases of engineering, exploring, mining, geology, topogra-

phy, construction and science. A copy will be sent free to anyone addressing The American Paulin System, Inc., Educational Division, 1220 Maple Avenue, Los Angeles, California.

Copies of the No. 1 Korite folder may be had by writing T. C. C. Laking, Manager of the Asphalt Department, Standard Oil Company, (Indiana) 910 South Michigan Avenue, Chicago, Illinois.

## Unit Construction Costs

### Construction of Cushman Dam No. 2, City of Tacoma, Wash.

(Low 5 Bidders of 11)

1. L. H. Hoffman, Portland, Ore. (awarded contract); 2. Lord & Bishop, Oroville, Calif.; 3. Morrison-Knudsen Co., Boise, Idaho; 4. J. M. Clapp, Seattle, Wash.; 5. W. T. Butler, Seattle, Wash.

No.—Item	Estimated Quantities	1		2		3		4		5	
		Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
1 River Diversion	Lump sum		20,000.00		44,400.00		25,000.00		55,000.00		39,000.00
2 Solid rock excavation	4,100 cu. yds.	2.60	10,660.00	3.50	14,350.00	3.50	14,350.00	3.00	12,300.00	3.00	12,300.00
3 Common excavation	600 cu. yds.	2.00	1,200.00	1.65	990.00	1.00	600.00	1.00	600.00	3.00	1,800.00
4 Solid rock excavation below elev. 323	2,750 cu. yds.	4.00	11,000.00	6.00	16,500.00	5.00	13,750.00	8.00	22,000.00	4.00	11,000.00
5 Common excav. below elev. 323	7,150 cu. yds.	2.60	18,590.00	4.00	28,600.00	3.00	21,450.00	4.00	28,600.00	4.00	28,600.00
6 Spillway exc.—solid rock	10,200 cu. yds.	1.30	13,260.00	2.00	20,400.00	2.40	24,480.00	2.50	25,500.00	2.25	22,950.00
7 Spillway exc.—common	16,100 cu. yds.	.65	10,465.00	1.00	16,100.00	.50	8,050.00	1.25	20,125.00	2.25	36,225.00
8 Drilling grout holes less than 30' deep	2,700 lin. ft.	3.00	8,100.00	2.60	7,020.00	1.00	2,700.00	2.70	7,290.00	2.90	7,830.00
9 Drilling grout holes bet. 30 and 60' deep	1,500 lin. ft.	3.00	4,500.00	3.00	4,500.00	4.00	6,000.00	2.70	4,050.00	3.25	4,875.00
10 Drilling grout holes more than 60' deep	700 lin. ft.	3.00	2,100.00	3.00	2,100.00	7.00	4,900.00	2.70	1,890.00	4.00	2,800.00
11 Drill. drainage holes less than 30' deep	1,000 lin. ft.	3.00	3,000.00	2.60	2,600.00	1.00	1,000.00	2.70	2,700.00	3.40	3,400.00
12 Drill. drainage holes between 30' and 60' deep	600 lin. ft.	3.00	1,800.00	3.00	1,800.00	4.00	2,400.00	2.70	1,620.00	5.00	3,000.00
13 Drill holes for anchor bars and rods and grouting	400 lin. ft.	.30	120.00	.35	140.00	1.00	400.00	1.50	600.00	2.50	1,000.00
14 Furnish. and inst. pipe and fit's. in dam for grout and insp.	4,300 lin. ft.	.20	860.00	.20	860.00	.60	2,580.00	.50	2,150.00	.30	1,290.00
15 Fur. and inst. pipe for press. grout in found. up to 1½" dia.	100 lin. ft.	.60	60.00	.60	60.00	1.00	100.00	.75	75.00	1.45	145.00
16 Fur. and inst. pipe for press. grout in found. for 2" dia.	400 lin. ft.	.70	280.00	.70	280.00	1.00	400.00	.90	360.00	1.60	640.00
17 Fur. and inst. pipe for press. grout in found. for 2½" dia.	100 lin. ft.	1.00	100.00	.85	85.00	1.50	150.00	1.25	125.00	1.90	190.00
18 Fur. and inst. Porous conc. tile for drain and insp.	500 lin. ft.	.35	175.00	.50	250.00	1.00	500.00	.50	250.00	.72	360.00
19 Fur. and inst. 2" G. I. pipe for drain and insp.	100 lin. ft.	.45	45.00	.75	75.00	1.00	100.00	1.10	110.00	1.60	160.00
20 Fur. and inst. 3" G. I. pipe for drain and insp.	200 lin. ft.	1.05	210.00	1.10	220.00	2.00	400.00	1.35	270.00	1.80	360.00
21 Fur. and inst. 4" G. I. pipe for drain and insp.	100 lin. ft.	1.50	150.00	1.50	150.00	2.00	200.00	2.00	200.00	2.20	220.00
22 Pressure grouting	800 cu. ft.	1.30	1,040.00	2.00	1,600.00	1.00	800.00	1.00	800.00	5.10	4,080.00
23 Sand for grouting	100 cu. ft.	.15	15.00	.50	50.00	1.00	100.00	1.00	100.00	5.10	510.00
24 Class "A" concrete	32,500 cu. yds.	4.60	149,500.00	5.80	188,500.00	7.00	227,500.00	5.25	170,625.00	5.65	183,625.00
25 Class "B" concrete	2,000 cu. yds.	6.70	13,400.00	5.80	11,600.00	9.00	18,000.00	5.50	11,000.00	5.65	11,300.00
26 Class "C" concrete	3,200 cu. yds.	9.00	28,800.00	8.25	26,400.00	10.00	32,000.00	6.00	19,200.00	5.65	18,080.00
27 Class "D" concrete	400 cu. yds.	8.00	3,200.00	7.50	3,000.00	10.00	4,000.00	11.00	4,400.00	6.10	2,440.00
28 Class "E" concrete	200 cu. yds.	18.00	3,600.00	27.00	5,400.00	25.00	5,000.00	15.00	3,000.00	6.30	1,260.00
29 Class "F" concrete	100 cu. yds.	45.00	4,500.00	20.00	2,000.00	30.00	3,000.00	30.00	3,000.00	6.65	665.00
30 Appurtenances for valve house — for the lot	Lump sum		1,850.00		2,500.00		1,000.00		1,200.00		3,440.00
31 Beaded copper water stops	6,300 lbs.	.65	4,095.00	.70	4,410.00	.40	2,520.00	.60	3,780.00	.72	4,536.00
32 Plain copper water stops	7,900 lbs.	.60	4,740.00	.60	4,740.00	.40	3,160.00	.60	4,740.00	.72	5,688.00
33 Rein. steel—in place	250,000 lbs.	.05	12,500.00	.042	10,500.00	.05	12,500.00	.05	12,500.00	.058	14,500.00
34 Steel anchor bars	6,600 lbs.	.10	660.00	.08	528.00	.06	396.00	.10	660.00	.072	475.20
35 Steel liner pipes for outlet valves —inst'd.	Lump sum		7,000.00		7,400.00		8,000.00		10,500.00		13,200.00
36 4—78" butterfly valves and appurt.—complete	Lump sum		25,000.00		23,400.00		27,000.00		43,000.00		38,400.00
37 Pipe handrail in place	420 lin. ft.	2.50	1,050.00	3.00	1,260.00	4.00	1,680.00	3.00	1,260.00	2.90	1,218.00
38 Steel trash rack for outlets in dam —inst.	18,500 lbs.	.07	1,295.00	.08	1,480.00	.07	1,295.00	.125	2,312.50	.10	1,850.00
39 Structural steel in drum gates—in place	292,500 lbs.	.125	36,562.50	.10	29,250.00	.12	35,100.00	.125	36,562.50	.127	37,147.50
40 Drum gate hinge and seat castings —in place	Lump sum		19,500.00		13,800.00		15,000.00		27,000.00		33,500.00
41 Automatic siphons and appurt.—in place	Lump sum		8,000.00		7,500.00		6,000.00		7,500.00		8,000.00
42 Drum gate trash racks, gates and access.—in place	Lump sum		7,500.00		7,000.00		4,000.00		8,500.00		10,600.00
43 Installing 13 lamp posts	Each	5.00	65.00	10.00	130.00	10.00	130.00	20.00	260.00	11.00	143.00
Totals.....			\$440,547.50		\$513,928.00		\$537,691.00		\$557,715.00		\$572,802.70